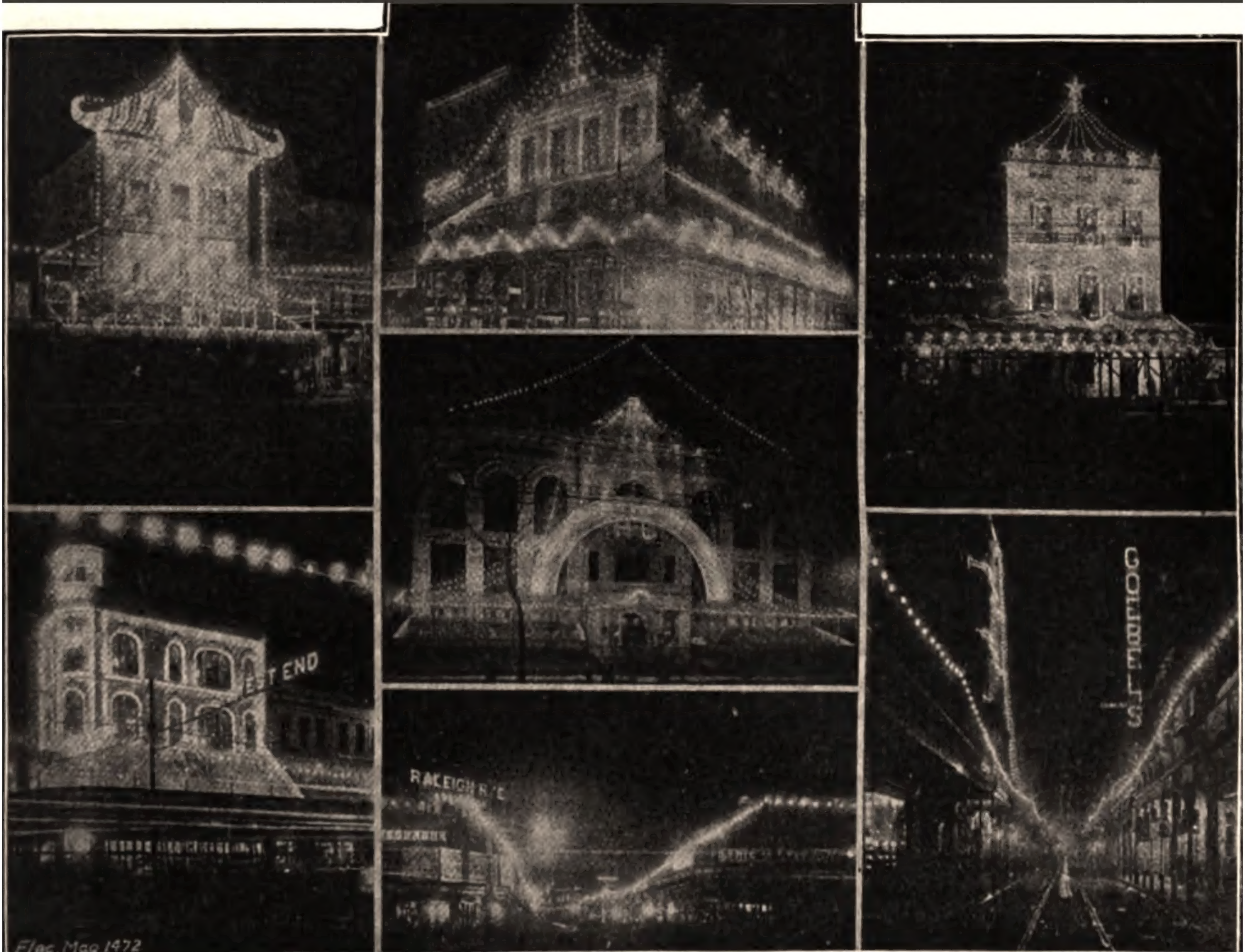

The Electrical magazine and engineering monthly

Alfred Hay.

The
Electrical Magazine

EDITOR-IN-CHIEF:

THEO. FEILDEN.

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INDEX TO VOL. IV.

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Telegraphy and Telephony.

Electro-Chemistry, Electro-Physics, and Electro-Metallurgy.

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The Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. IV. No. 1. (19th Issue.) LONDON. JULY 29, 1905.

The World's Electric Progress.

Our Fourth Volume. IT is with an intense feeling of satisfaction that we embark on the fourth stage of our career as a technical and commercial electrical journal. We can look back upon periods of the most encouraging progress, particularly during the last six months, and at this moment we have won the support of a very wide circle of appreciative readers extending far beyond the confines of Great Britain—our subscribers, in fact, are to be found in the remotest corners of the earth. So many of our readers have expressed the wish that matters of commercial interest should be given separate and distinct space in the issue that we are adopting their suggestions, and in future the text of the magazine proper will close with the "Review" section. Beyond this readers will find a highly interesting and valuable record of manufacturing progress and details of the enterprise of electrical manufacturers generally, embodying useful data and particulars of their most up-to-date products. We extend our hearty thanks to the large body of subscribers and readers who have supported us in the past, and feel that our efforts on their behalf in the future will result in an even greater expansion of the scope of this Journal.

Our Special Supplements. THE attention of readers is directed to the special Supplements, which form an important portion of the Magazine this month. Special reports will be found therein of the I.M.E.A. Annual Convention, the M.T.A. Annual Conference and the Electric Tramways and Railways Exhibition, recently brought to a close at the Agricultural Hall. Full details of these meetings and the exhibition will be found in our reports, and we trust that engineers will therefore keep the entire issue for reference or extract one or other of the Supplements, putting them on file until the next year's gatherings. The usual sections of the magazine will also be found of more than ordinary interest this month. We have set aside special space for dealing with the aspects of electrical design and manufacture, and hope that our readers will appreciate this addition. The number of designing engineers and highly technical men associated with manufacturing concerns is on the increase, and it is with a view to catering for their particular interests we are allotting space to data and illustrations which cannot but prove to be exceptionally valuable. We open the new section with a serial from the pen of no less an authority than Mr. H. M. Hobart, and shall follow this up with representative contributions from equally eminent experts. We invite contributions from engineers engaged in this important branch of electrical work, and shall ourselves spare no effort to give a high tone to the contents of the section in question.

A Plethora of Conventions. THE past two months have been crowded with important conventions of electrical engineers in all parts of the world. The early days of June saw the assembly of the Verbande Deutcher Elektrotechniker at their Thirteenth Annual Meetingat Dortmund, and at the same period the German Bunsen

Society met at Karlsruhe. (A special report of this meeting will be found in "Electrophysics" this month.) In America, the National Electric Light Association, the American Street Railway Association, and the Institute of Electrical Engineers have all been holding their Annual Conferences, while in this country the Municipal Electrical Association and the Municipal Tramways Association have also been exchanging experiences. We have devoted special space in this issue to the proceedings at the annual meetings of the last two Associations, while reference to the papers read before all the others will be found in our "Electrical Literature" section for June and July. The Asheville meeting of the American Institute was especially notable on account of the many valuable papers presented. Among these were two advocating strongly a return to three-phase traction for railroads, and some further particulars of these are given elsewhere. A new method of treating carbon filaments resulting in a much higher efficiency was also described and discussed, and from the results of the experiments detailed there seems to be every prospect of placing carbon filament lamps on a competitive level with the new metal filament lamps which will soon be on the market.

The Late John T. Connolly. It is with deep regret that we have to record the death of Mr. John T. Connolly, who was one of the founders and a managing director of the firm of Connolly Bros., Ltd., insulated wire and cable makers, of Manchester. Mr. Connolly, who, we understand, died after a very short illness, was a close personal friend of the Editor of this Journal, by whom he is sincerely mourned —as he will be by his very wide circle of admirers and friends. He was a genial companion and a true friend; and those who had the pleasure of his company on the American tour, as Mr. Feilden had, will testify to the warmth of his nature and the sincerity of his character. Mr. Connolly was educated at the Islington School of Science and Art (one of the pioneers of the present-day technical schools), where he gained a scholarship. He was apprenticed as a mechanical engineer to the firm of Hayward Tylor and Company, of London and Luton. He afterwards went to Milan as assistant to his father, who introduced the manufacture

THE LATE JOHN T. CONNOLLY.

of insulated wire and cables in Italy for the now well-known firm of Pirelli and Company, Milan. He was subsequently engaged in England, on the Continent, and in the United States in the manufacture of india-rubber and gutta-percha insulated wires and cables, and also in the erection of some of the largest electric light installations in the eighties, notably for Lever Brothers, Port Sunlight, and the Co-operative Wholesale Society, Manchester. He was an accomplished linguist, a man of high scientific attainments, and a member of the Institution of Electrical Engineers. Mr. Connolly leaves a wife and a young family, and we offer them and the members of the firm our sincerest condolences in their irreparable loss.

Revolutionary Prime Movers. THE reciprocating engine may be very good in its way, but it falls short in not being quite good enough. Turbines and rotary engines are responsible for a higher education which is moulding the ideas of the younger school of engineers on entirely new lines. Electricians at the outset wanted a rotary engine to drive their dynamos, but the engineer could only say them nay and offer a desperately poor substitute which has had to do duty in the meantime for want of a better. But the steam turbine has now asserted its authority and we have hopes of a gas turbine in the near future. Up to the present the

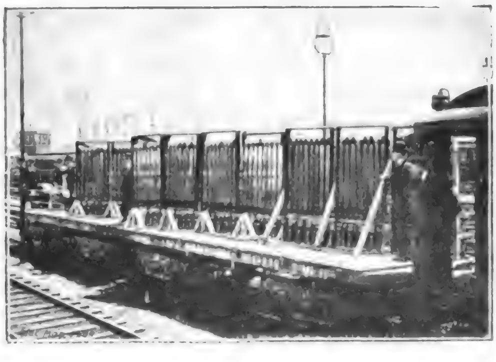
velocity type of steam turbine has held the field and is now in extensive use. Its losses are, however, notorious, while its construction for so simple an engine is very costly and in some details unmechanical. We have recently inspected a highly interesting form of pressure turbine which, in addition to operating with steam, can also be made to run with any other vapour. At the moment we are not at liberty to give details, but the principles and construction of the machine are so simple that it has every appearance of a revolutionary prime mover, valuable not only in electrical circles but in every known field of power employment. When developed for the driving of dynamos it will prove an ideal engine, whether built in the vertical or horizontal type, and in the former case it will require no complicated footstep bearing with hydraulic accessories or safety devices. Being a pressure device, it can be operated at low speeds for large powers and economies considerably above those obtaining at present in advanced practice. After a brief preliminary inspection we were much impressed with the many good points of design and constructional details of this new turbine, and look forward to developments in the next few months which will fully substantiate the claims made for it. Interested engineers should either communicate with us or call, when we shall be pleased to give them an opportunity of inspecting the machine. Makers of reciprocating steam and gas engines meantime can consider they have received their *congé*.

Their Name is Legion.

We have received preliminary particulars of the Legion of Frontiersmen. These pages we commend to the notice of Electrical Engineer Volunteers and others of a patriotic turn of mind. The Legion is defined as a body of men who have been trained by working, hunting, or fighting in the wilderness or at sea. Being adapted for special work not now arranged for in His Majesty's forces they will prepare at their own cost and hold themselves in readiness to serve the King in time of war. Their only motive in coming together is patriotism, their sole ambition to aid in the defence of the Empire. The Legion is based on an ancient custom of the British people. Before there was an Army all able men were required to hold themselves in readiness and rally to the standard in time of national peril. Like the original militia, the corps will not be military, but civil, and under no military authority except when on active service. There is no age limit, and veterans are invited to join and help the Legion. Permanent camps will be arranged very near the great cities, and men attending their usual work in town will be able to spend a few weeks under canvas at any time they please. All the plans seem to have been very carefully thought out, and the preliminary circular contains volumes of information which should be perused by interested parties. The Legion has been founded by the Rt. Hon. the Earl of Lonsdale, and Mr. Pocock, of 6, Adam Street, Strand, will be delighted to furnish any information required.

Subway Sensations.

Despite the maledictions of Nikola Tesla, or perhaps we should say in consequence of them, the sensation of riding in New York's Subway can now be realised



Taking Moving Pictures in New York Subway.

without taking a trip through its malodorous atmosphere. A series of animatographs have been taken, and seeing these worked off on a screen conveys the idea of rapid motion, as is well known, with exhilarating effect. Of course these moving pictures can only be taken by some highly actinic form of artificial light. This was provided in the shape of 72 Cooper-Hewitt mercury vapour lamps representing a total brilliancy of 54,000c.p. This, by the way, is probably about as much "sunlight" as the Subway will ever be blessed with. The lamps in banks of nine were mounted in frames placed diagonally on a flat

truck, the result being that the light was thrown immediately ahead of the car fitted with the photographic apparatus. Current was obtained from the third rail, and a 40h.p. motor generator set was operated, giving a continuous current of 110 volts for the lamps. Obviously difficulties would have arisen in starting the lamps by the usual tilting methods, so kicking coils were placed along the bottom of the frames. A special polished reflector was fitted to each lamp, and the results obtained were in every way successful. Details of the subway construction were brought up with extraordinary sharpness, and the scenes included a number of stations with passengers leaving or boarding the local trains. Our American friends are too enterprising to be stopped by trifles. Perhaps they will come over and repeat the experiment, and we may yet see animatograph views of London's c nverted Underground or of the older type lines, which have evidently proved no attraction to the cinematographer in this country.

Shoreing a Telegraph Cable.

THROUGH the courtesy of Mr. A. Murray, of Waterville, Ireland, we are able to reproduce an illustration of the landing of the Commercial Company's fifth Atlantic cable on the Irish Coast. The cable was being landed from the Telegraph Construction Company's cable ship "Cambria" when the snapshot was taken. The method employed to land these heavy cables may be of interest to our readers. Two light ropes are first brought ashore by boat. One is passed round a pulley firmly secured in the ground and spliced to the second. On an agreed signal being given, the ship, which is, of course, anchored, hauls on one end of the rope, and a heavier rope attached to the other end is drawn in to the shore. This also passes round the pulley and is taken back to the ship, but previous to its second end leaving the vessel the cable itself is attached to it. A number of barrels are then fixed at regular intervals between the vessel and the shore, and over these the cable passes. The "Cambria," by the way, is the latest addition to the fleet of the Telegraph Construction and Maintenance Company, and is a twin screw steamer of 1,954 tons gross register. She can carry 800 miles of deep sea cables, and is now on her way to Cape Canso, Nova Scotia, selecting the new cable route across the Atlantic. The photograph was taken by Mr. H. P. Endean, of the Commercial Company's Station, Waterville.

LANDING ATLANTIC CABLE AT WATERVILLE, IRELAND.

Tramway Pioneering.

THE tramways engineer is too fond of resting on his laurels. He forgets that his steam driven plant and series motors are not the most desirable things with which to operate his cars. That this is really so was made abundantly evident at the demonstration given on the Birmingham and Midland tramways system quite recently. At the invitation of the chairman and directors of Raworth's Traction Patents, Ltd., a number of engineers and tramway managers were taken to Birmingham to inspect two cars fitted with distinct developments of a regenerative system. These cars were respectively controlled by motors connected in simple series and in series parallel. The Birmingham cars are all fitted with regenerative control, and the energy consumption has been found not to exceed .97 Board of Trade units per car-mile. Such complete confidence is placed in the system that no brake blocks have been fitted since the cars started. Space will not permit us to

A possible outcome of Municipal Trams, à la Glasgow, in Chicago, as seen by an American Artist. *(Further comment is needless.)*

(By kind permission of the "Chicago Daily News.")

speak of all the other economies effected on the cars, because we wish to reserve some remarks for the power house. This was undoubtedly the attractive feature of the day, and engineers seemed loath to leave the four Diesel engines direct coupled to generators at the Yardley power station. These engines ought all to be honoured with some distinguishing name, as they are the pioneers of their kind direct connected to traction generators in this country. They are each of 160b.h.p. and their operating cost for oil fuel is only .185d. per unit. This gives the amazingly low total works cost, including repairs and maintenance, of .44d. per unit for a station of 400kw. Such figures as these are only obtained in places like Glasgow, Leeds, Newcastle, and Sheffield, where the total number of units used per annum is upwards of 10 to 15 millions. This is a record on which the Diesel Engine Company may well pride themselves.

Traffic Commission Report at Last! AFTER many weary months of waiting, the Royal Commission on London Traffic has presented its preliminary Report. That the period of suspense has been well and wisely utilised is amply evident

from the Report, and its recommendations will certainly have a penetrating and far-reaching effect. Space in this issue does not permit us to give more than a bare idea of the principal suggestions made, but in our next issue we shall publish fuller details. The Report has only reached us at the moment of going to press. Chief among the proposals is that for a Central Traffic Board, nominated not by local authorities but by Government, to have jurisdiction over the transit of Greater London. The Board should engage itself wholly and solely with these particular affairs. The other recommendations refer to the provision of about fifty-three miles of tramways within the County of London, several miles of subway, and additions to the existing City and suburban railways. On the subject of electric traction the Report speaks with the emphasis of conviction, and we commend this indubitable recognition of its merits to the advocates of the motor 'bus. This much-belauded vehicle meets with scant treatment at the hands of the Commissioners, and, if their advice is followed, will get but the offshoots of London's thronged thoroughfares to serve with its malodorous racket. When put into practical effect, the proposals, either of the Commissioners or the Traffic Board, will impart a two-fold benefit: the electrical industry will be provided with a task worthy of its name and calling; and Londoners, with a transit system equalled by none in the world, will boast of commodious, secure, and efficient transport facilities of which they have been too long denied.

Electric Ship Loading.

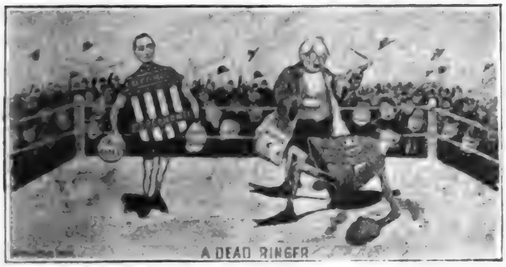
In American as well as European harbours the great steamship lines are taking advantage of every labour-saving device available which will ensure a more economical and swift method of loading and unloading the great vessels lying at the wharves. A new electrically operated registering conveyor capable of passing 4,000 sacks per hour to the deck of a vessel, automatically counting and registering absolutely without error, has just been introduced and is illustrated herewith. The conveyor is 50ft. long and of steel construction, loading freight on the mammoth twin screw steamers with the greatest ease. In addition to the conveyor, two or more trailers may be employed in conjunction for conveying goods, luggage, &c., from the inside of the warehouse, while another conveyor of the same type carries the material across the deck of the steamer. Delivery to any point desired can thus be effected, and the combination gives an equivalent of a single conveyor 140ft. in length. A number of these electrically-operated labour-saving devices are in operation at the New York docks of the Old Dominion Steamship Company and the Northern Pacific Railway Company, and we may shortly expect to see something of a similar nature on this side the herring pond. A 5h.p. motor is utilised for driving the travelling apron, which runs on steel anti-friction roller bearings—rollers set two inches apart on both sides of the conveyor—thus reducing the friction to a minimum, and making it a most economical type of conveyor and labour-saving device.

Electric Ship-loader in use.

Slats are used instead of a belt, so that cased goods, barrels, bales, or other kinds of package freight can be more readily handled. A special controller varies the speed from 75ft. to 175ft. per minute, according as light or heavy material is being handled.

Telephone Advertising.

A TELEPHONE service does not at first sight appear encouraging material with which to canvass for advertisements. Probably a traveller in dry goods would think so, but nevertheless a telephone business can be "developed" by judicious publicity, as experience has conclusively proved. The American telephone papers, which, by the way, are both numerous and enterprising, have recently published in the full light of whole page display a sample poster circulated by the Cuyahoga Telephone Company.



A SPECIMEN OF AMERICAN TELEPHONE ADVERTISING.

As our reduced reproduction shows, the Independent Champion is seen in the act of exulting over his fallen opponent, who has received a knock-out blow. The wretched looking and cracked bell is unable to come up to scratch, and the delighted spectators, among whom presumably the local celebrities figure, are giving vent to their enthusiasm in the usual uproarious manner. Now in this country we are badly in want of telephones—domestic telephones—and it looks as if some warrior of Independence is needed to administer a lesson or two to Monopoly on cheap telephones and efficient service. At any rate the experience and example of Americans in this field will bear both scrutiny and emulation, and we hope the communication caterers of this country, be they municipal or company, will profit by some, at least, of the lessons which are applicable to their case from American practice in telephone business getting.

THE WINDMILL.—V.

Operated by DON QUIXOTE.

The Destruction of Town Refuse.

MAN is a grasping animal; possibly that is due to our forbears, the monkeys. In the far-off days of the simple life, our woad-bedecked ancestor would first catch his ichthyosaurus and then call the wife of his bosom unto him. They would between them dismember the beast and select the tenderest cuts for immediate mastication. Cooking was unnecessary in those days. Having polished off the meat from the bones and picked their teeth with the splinters, they would fling the refuse together in a reeking heap, and a day or so afterwards would look out for a new house on account of the smells from this first-type refuse destructor.

Later, our ancestors got fat and lazy, and preferred that the refuse should get out of their way rather than the opposite process. They therefore bred dogs, who by disposition and starvation became the next-type destructor. The only trouble about the dog was that it was too efficient. When it had done chewing up the refuse it began to chew up the marketable commodities, and the mysterious disappearance of an odd slave or two roused public opinion to the fact that a more economical apparatus was needed.

As civilization progressed, the dog was superseded by a combination of man, cart, horse, and big bell, adapted from the Great Plague of London. On the sounding of the bell as it passed, the inhabitants brought out their dead cats and other unconsidered trifles, and these were carted to waste spaces, where for a time they were left to fester. Then houses were built upon them, in which the poor lived. And yet men were not satisfied.

Then arose one at Paddington who thought that on the whole it might be healthier to burn the garbage, and a furnace was built. And after trying very hard, and wasting much coal and developing an awful stink, the promoters decided that the scheme turned out a dismal failure, and the owners of ground-rents for cheap houses said, "I told you so." Nevertheless, in 1876 a furnace was made which burnt its own refuse and to a large extent consumed its own smoke. But yet men were not satisfied.

For one of them happened to lean up against the flue, and lo, it was hot! "Let us clap a boiler on the top of this furnace full of garbage," said he, "and boil our own

water." And they did so. And the partially consumed gases having various quaint chemical formulæ and atrocious odours, prematurely cooled against the tubes of the boilers and laid the town flat on its back. And still men were not satisfied.

Then arose a genius who said, "Let us jolly well pump air into that furnace till it sizzles!" and they did so; and the water boiled, and the gases were consumed, and clinker was formed of exceeding hardness. And they laid the clinker in the roads, and it was very good. And still men were not satisfied.

For someone said, "We want light to lighten our darkness. Why do we use this steam to grind our mortar-mills? Let us stick an electric light station on to the end of this cat-crematorium, and bring our fuel cost per unit down to minus nought fivepence." And when men found they couldn't do that, they were more discontented than the primeval specimen who had to move out of town to avoid the hum of his ichthyosaurus. And this, I think, proves that mankind is a trifle grasping in its requirements.

It is because of this skinflint disposition in humanity that I propose to make a divergence from the usual method of pleading for destructor plants. The commercial prosperity of a destructor station is not the only criterion of its usefulness. The question ought not to be "Is it successful?" but "Is it sanitary?" The existence of a destructor in a town ought to go without saying: if electricity can be recovered from it, so much the better. I am aware that some Borough Councillors would sooner spend money on tin-shed isolation hospitals than on a proper sewage system, for economical reasons, and in the present hubbub against municipal extravagance this type of dog is having his day. I would emit a counterblast. I would go the whole hog. Let there not only be a dust destructor in each municipality, but also a crematorium attached to it, and let each contribute its quota to the general illumination. There is something sublime in the conception of a Borough Councillor bequeathing the worn-out casket that erstwhile contained his dauntless spirit to the municipality, consummating a life spent in doing good by a crowning act of public beneficence. He would probably achieve the most brilliant success of his life after he was dead, so to speak.

I would also plead for the destructor station on account of its chastening and refining influence on the employés within it. To a shift engineer of a contemplative turn of mind, what a vision of the world's transition is unfolded. Here, down to the ash-shoot, fouled by sodden ash and mixed with sweepings from a gutter, comes the mangled remnant of a woman's dress. Once it fluttered in the wind, a flaunting piece of lady's bravery. Down it comes at last, and ere long disappears into the seven-times heated furnace, to be utterly consumed. I wonder if the owner, like the thing, has been cast out among the garbage of the world? And here, rolling along together in dissolute drunken companionship, come two empty bottles, all the best of them gone—only the empty outsides remaining. One has a slender neck with silver paper wrapped round it; the other is vulgar and squat, with a bloody hand on its label. No matter now that one held champagne and the other nothing but stout. Down the shoot they come tumbling, and soon they will be dross together.

That is all very well, but the shift engineer may have too much of a good thing. For instance, in one destructor station they kept up the steam with a packet of unused cartridges that some misguided man had thrown into his ashtub. When these fairly got alight the Irish stoker walked quickly into the engine-room with the remark that the divil had got into the combustion chamber and was thryin' to push the boiler into the canal. The report of the engineer in charge included the statement that the calorific value of the refuse on his shift had been most satisfactory, but that combustion was too spontaneous to keep a steady voltage line. The furnace required quite a lot of patching next day.

POWER: and its application to INDUSTRY

Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Electric Power on the Clyde.

DESPITE its importance as a centre of engineering activity, the Clyde valley has only recently had provided an adequate, reliable, and efficient power supply for the general use of large industrial concerns situate within the area allotted the undertakers—the Clyde Valley Electrical Power Company. It would almost seem an after-thought of the electrical engineer, this raising of power stations in a great shipbuilding district, when most other areas, "smoke begrimed and murky in the grip of steam," have long since possessed the blessed privilege of a bulk service even if they have failed to advantage themselves fully of it. On Monday, June 21st, however, one of the first two power plants to be put into operation was opened at Yoker, the second station, at Motherwell, being near completion. The main features of both installations are the same, so that in mentally conducting the reader over Yoker we are also presenting details of Motherwell, the items of difference being in the condensing plant.

The supply area claims first attention. As will be seen by the map on the next page, it is practically bisected by the river Clyde and extends from Lanark and Shotts on the east to Craigendoran and Port-Glasgow on the west, a "territory" comprising some 750 square miles. Within the compass of this are some of the largest engineering concerns in the country, while coal is to be had in abundance. Inside the boundaries are also numerous suppliers of electrical energy, which are signified on the map by the shaded portions. These authorised undertakers include the city of Glasgow, whose stations aggregate some 26,000h.p. for lighting and power purposes, but the new company has no powers to supply in this area or in those of the smaller undertakings unless any or all should elect to become its consumers.

It is perhaps well that the stations of the company have not been hurried into being, and by undue haste equipped with units outdated at their birth by some improved type of generating outfit. Though delayed in erecting, the stations now completed are stamped with marks of the new era in the types of prime mover installed, and this circumstance—the adoption of turbo-generators—at once relieves the management of baneful anticipations of revolutionary improvements threatening the uniformity of their plant, and of a heavy repairs and maintenance bill at the year end.

Yoker Generating Station.

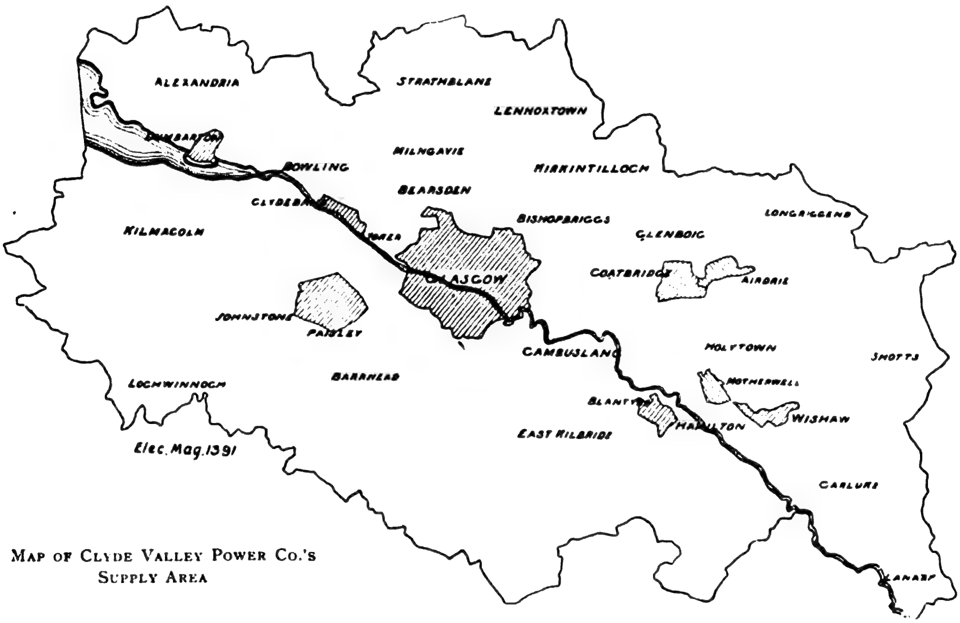
The main engine room is 252ft. long by 43ft. wide, and its walls are faced with white glazed bricks to give the maximum of light. At the south end are situated the switchboard galleries and offices. The entire works are thoroughly fireproof, and with the exception of the office doors and window sashes, there is no woodwork in the building; in fact, as an extra precaution the office block is entirely isolated from the engine room by iron fireproof doors. This section of the building occupies two storeys and comprises offices for the station superintendent, storekeepers, timekeepers, and store-rooms, lavatories, &c. The

boiler room measures 186ft. long by 50ft. wide, and over it are the coal bunkers, while at the north end is the chimney. The coaling arrangements are most complete, and from start to finish the fuel is untouched by hand. Coal is brought in wagons to the company's private siding, and, after being dumped by a hydraulic ram into a crusher pit, passes through a crusher and screen operated by a motor; it is then picked up by the conveyor buckets, and carried to the storage bunkers over the boiler house, whence it passes automatically to the boilers, being weighed—also automatically—in transit, the number of hundredweights used being recorded on an indicator. The conveyor was constructed by Messrs. Graham, Morton and Co., and is motor driven. The same conveyor is also used for carrying the ashes away from the boiler house.

There are at present in the boiler house four double-drum Babcock and Wilcox water-tube boilers, fitted with superheaters capable of imparting 136° F. of superheat. The steam pressure is 165lb. per square inch, and each boiler is equipped with a Roney mechanical stoker, driven through special worm gearing by two Westinghouse standard engines.

The main generating plant as at present installed consists of two 3,000h.p. Westinghouse-Parsons steam turbines having an overload capacity of 3,750h.p. and running at 1,500 revolutions per minute. The turbines are of the latest double-flow pattern, steam entering at the centre and exhausting at both ends. Each set exhausts directly into its own surface condenser, which is of the vertical type, by the Mirrlees, Watson Company, and provided with steam-driven two-stage dry air pumps situated in the basement. The circulating water for the condensers is drawn from the River Clyde, running by gravity into a large circular well, 18ft. in diameter and of a depth below low water level of 9ft. Each of the turbines is directly connected to a Westinghouse 2,000kw. generator, generating three-phase current at 11,000 volts and 25 periods per second. At this pressure current is distributed to the various substations. The engine room as at present constructed will accommodate one more unit of 2,000kw. and one of 3,500kw., which will make the total capacity of the station 9,500kw. or 13,000h.p.

There are two exciter sets, each of 75kw. capacity, generating direct current at a pressure of 125 volts. They are situated, with the other auxiliary machinery, in the basement, and supply current to operate the motors of the coal and ash conveyor, crushers, agitators, economisers, and pumps,



Map of Clyde Valley Power Co.'s Supply Area

as well as for the electrically-operated main switches.

The complete switch-gear is situated at the south end of the engine house, and is distributed over four floors. In the basement the outgoing cables are connected to the terminals of the switchboard, and here also are the protective devices against undue rises of pressure. On the first floor at engine room level are the switches controlling the outgoing feeders, and also the main generators. On the first gallery are two rows of switches, which allow either the generators or outgoing cables to be connected on to either one of the duplicate set of 'bus-bars, thus ensuring continuity of supply at all times. On this gallery are two motor generators, each of 150kw. capacity, for supplying current at 3,000 volts, 50 periods, three-phase, to the Clydebank district, the Provisional Order for which was acquired by the company. The motors of these sets take 25 period 11,000 volt current from the main sets without the interposition of transformers, and are direct-connected to generators, which work at 3,000 volts, 50 periods. Each set is provided with a small motor coupled to the shaft for starting and running up to speed.

On the second or top gallery are placed the main 'bus-bars and the main controlling board, as well as the resistances, &c. The control board consists of a small desk directly facing the various instruments, such as ammeters, voltmeters, power factor meters, indicators, relays, &c. All the main switches and smaller gear are electrically operated from this desk by the exciter current, and the speed of the turbo-generators and their starting and stopping is also controlled from here. The operation of the engine room is thus practically centralised in one spot, which, besides offering a maximum of convenience in working, greatly reduces the chances of breakdown. On the third gallery is also situated the switchboard for the distribution of the 3,000 volt current to the Clydebank area.

The trunk mains from Yoker to Clydebank are already laid, as well as nearly all the distributors required in that area. In addition, conduits are laid for drawing in further cables to Clydebank on the west and Scotstoun on the east, and the cables to Temple are now being laid. In a very short time the cables will be ready for supplying power to any part of the district between Clydebank, Scotstoun, and Temple. All cables are in duplicate, so that, should accidents happen, the spare main can be connected immediately while the duplicate is being repaired. In addition to the generating stations, the company have also in hand the laying of a comprehensive system of mains and the erection of a number of transforming stations, situated at the most convenient points for serving the largest number of users of electrical energy. Energy will be supplied on the three-phase alternating current system, and the motors used will be of the induction type.

A Typical Steam Turbine Power Plant.

THE United States has quite recently afforded several interesting cases in which a number of short tramways or "street railways," each with its own power plant, has been purchased by a controlling company and merged under one central organisation. This consolidation of interests generally results in the concentration of the power centres into a plant of modern design under

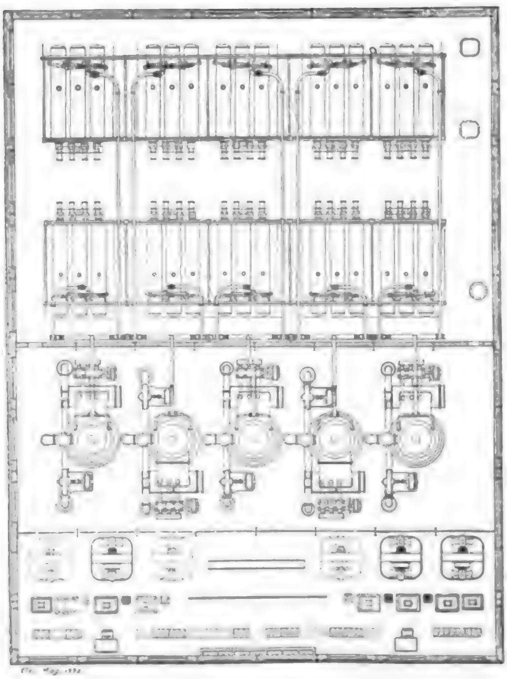


FIG. 1. PLAN OF QUINCY POINT STATION

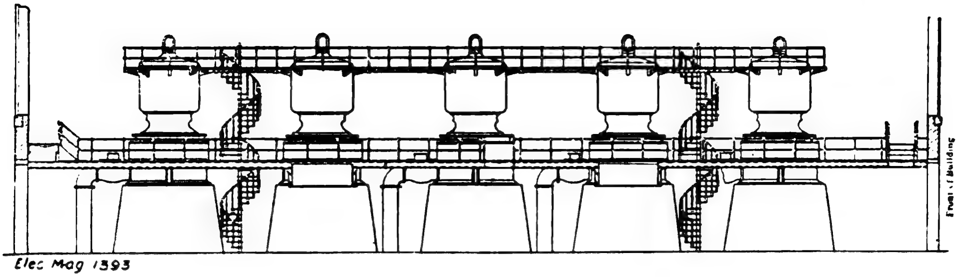


FIG. 2. ROW OF CURTIS TURBINES, SHOWING GALLERIES.

one roof. A typical and admirable instance of this is the Quincy Point station of the Old Colony Street Railway Company, a body operating a railway "territory" sixty miles long by thirty miles broad. The new station assumes the supply responsibilities of no less than eleven plants, most of which have been or will be abandoned. The new scheme also provided for the equipment of a station at Fall River with high tension plant, but the forty-five miles separating the two stations has proved no deterrent to the supply of direct current to Fall River from Quincy Point; consequently the proposals for this development will not yet be carried forward.

Interest in the equipment at Quincy Point centres round the generating units, four in number, each a vertical Curtis turbine of 2,000kw. capacity furnishing 13,200 volts, three-phase 25 cycle current direct to the transmission lines. Fig. 1 is a plan of the boiler and engine rooms, and adjoining the latter will be noticed rotary converting plant for serving the local stretches of line with direct current. The generators are placed in a line, and galleries, as shown in Fig. 2, are provided for both the turbine and generator levels, these galleries being continuous from unit to unit. This allows of a minimum of trouble in attendance, and reduces the number of ladders giving access to raised parts of the machines. The boiler house contains ten sets of triple drum water tube boilers arranged in two rows (Fig. 1), with piping connected to a common header fitted with sectionising valves to allow of two boilers serving a single turbo-unit if necessary. Fig. 3 is a sectional elevation through the complete station, and this gives an excellent idea of its compact design and neat arrangement of plant. The boiler house is especially compact, though the suspended flues may not meet with the approval of English engineers. These will be seen in the right and left top corners of the boiler house, directly below the roof principals, the uptake from the back of the boiler setting being omitted in the drawing (Fig. 3).

The turbines occupy the centre of the engine room, and surmount a longitudinal concrete block with cavities above and below the gravel fill. These spaces, which extend the length of the plant, contain at the top the free exhaust pipe to the atmosphere, and, at the bottom, the suction and discharge sewers for condenser water, which is drawn from Boston Harbour. The condensing plant which adjoins each turbine is mounted above the intake and outlet for the water, and pipes depend into the space below the engine room floor into the respective cavities connected with the harbour. By this method all pipe work is concealed, though it is none the less accessible, and much valuable space is saved. It will be noticed in the plan of the station that the condenser barrels are

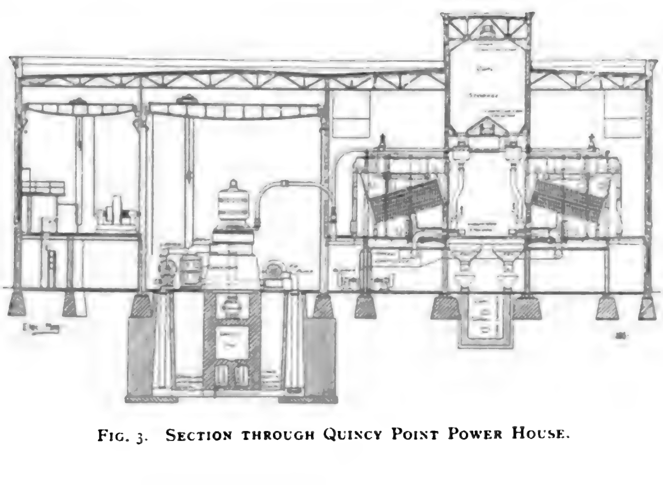


FIG. 3. SECTION THROUGH QUINCY POINT POWER HOUSE.

staggered, on each side of the turbines, alternately with the circulating pumps.

A feature of the plant is the return of the condensed steam to the boilers, the hot well being directly drawn upon by the feed pumps. Three tanks go to form the well, and the water supply is maintained from the city mains. The absence of oil in the steam enables this economy of water to be effected, and it is interesting in that only by expensive filtration could condensed steam from reciprocating engines be returned to the boilers.

The transmission line has no special features, as the voltage is comparatively low. At present six substations are supplied from Quincy Point, and each has rotary converter plant fed through air blast transformers. These latter are a departure from common practice, in that the core and copper comprising the transformer for each phase are assembled under one housing instead of in three separate tanks.

Induction Motors for Machine Drive.

POLYPHASE induction motors are not frequently used for variable speed work unless some mechanical speed changing device is inserted between the motor and its work. In a few isolated cases variable speed induction motors are put down, but complete installations of such machines, to the entire exclusion of all others, are the exception rather than the rule. The Great Northern Railway Company, U.S.A., have large railway works at St. Paul, and these have been driven for two years past by polyphase induction motors, several of which are wound for variable speeds. An article describing the installation recently appeared in the *Electrical World and Engineer*, and the concluding paragraphs contained the eulogies of the staff in charge of the motors, on their general satisfactory operation, freedom from breakdown, and microscopic cost for maintenance. Some eighty-four motors are installed, and about forty odd of these were of small size coupled directly to various machine tools. Our esteemed contemporary regarded the installation of sufficient importance to expatiate editorially upon it, and among other things said: "There has been much difference of opinion as to the relative merits of alternating and direct current for shop distribution and operation, many having claimed that the direct-current system was the only practical method, the other being a makeshift whereby economical results could not be expected. Yet this installation adds another example of the use of the induction motor. The simplicity and reliability of the induction motor were considered as of importance equal to, if not greater than, the somewhat greater flexibility of the direct-current motor. The elimination of the commutator and consequent reduction of wear and attendance, the possibility of continuous and uninterrupted operation under adverse conditions, and the general disregard of abuse, inherent in the induction motor, are factors worthy of consideration." Further remarks in praise of the induction motor followed, but the glove thrown down was not long in calling out a champion from the direct-current ranks. Mr. R. T. Lozier sat long in the saddle expectant of some doughtier knight than he to enter the lists, but the lapse of twenty days saw him lance in rest tilting at the enemy. In a letter to the editors he commences thus: "I have looked expectantly for some far more abler exponent than I for the direct-current motor to set lance and ride a tilt against the assumption that the induction motor is better than it for variable-speed tool drive. It is possible that they feel that past tourneys have so often settled this matter in favour of the direct-current motor for this particular purpose that it is not necessary to ride again. Feeble a champion as I am, however, I cannot allow the challenge so clearly written to go unnoticed. The issue is plainly this: Is the alternating-current system the best for use in a shop using individual tool drives, and in which variable speed motors are an important factor? It is granted in your editorial comment that the operating efficiency of the induction variable-speed equipment is no doubt somewhat less than that of the variable-speed, direct-current motor, but you claim that the advantages of uniformity of equipment and simplicity of the distribution far outweigh the shortcomings as to efficiency. Does the description found in the article describe such conditions? It says that:

"(*a*) The generating plant consists of separate generators for power from those required for lighting, and in addition to these three units a fourth is necessary for exciting purposes.

"(*b*) The connections of the board are arranged with an idea of avoiding parallel operation of the generators.

"(*c*) The drooping voltage characteristics of the generators is dependent upon to protect them in case of short circuits at the bus-bars.

"(*d*) Separate circuits are required for lighting, which must be independent of the power.

"(*e*) That transformers are necessary to change from three-phase to two-phase, with neutral wires in order to provide for distribution to this lighting; these transformers in most cases are placed in tunnels, and their fallibility is acknowledged, because in their largest installation 'the secondaries of the two sets are arranged to be interconnected in case one set fails.'

"Compare the foregoing with a simple two-wire, direct-current plant in which the same generator is used for both lighting and power purposes; and when more than one is used the economies of load distribution are enjoyed because of parallel operation. The same conductors may supply both branches of the service. Compact, efficient motors are used, having a speed range of at least 2 : 1, obtained by field control, the most convenient and efficient of all methods. These motors have unity power factors, better torque conditions, and the clearance between armature and field gives safer mechanical construction than is possible with the induction motor."

Further arguments and a curve follow in support of Mr. Lozier's contentions, but his summing up is, we think, the best part of his case: "In closing, let me state that the electric motor has really only just begun to come into general use. Its future market is enormous, the demands of which are most varied—the alternating-current motor meeting the requirements to which it is best adapted, while the direct-current motor has its particular field. The increase in alternating and direct-current motors will be like the increase in the population, in which part will be boys and part girls. And the former will be dressed in pants and the latter in skirts, and an exchange in either case would be equally unwarranted."

Electricity in a Malleable Iron Foundry.

It is often put up against American manufacturers that they have no old plant to scrap when asked to instal electric drives. The following particulars, communicated by Mr. H. P. Kernochan to the *Electrical Review*, N.Y., clearly refute this statement and should form an object-lesson to British power users, who so often protect themselves from the importunate motor canvasser by getting behind their steam plant.

Electric power, transmitted at 20,000 volts from the water-power generating stations at Spiers Falls, N.Y., and Mechanicsville, N.Y., and stepped down for distribution to 2,200 volt, forty-cycle, three-phase current in the Watervliet substation of the Hudson River Water Power Company, is now furnished to the Troy Malleable Iron Company, Watervliet, N.Y., for power and lighting. The motor applications comprise individual and group drives and replace one 225h.p. and one 125h.p. steam engine, about 350ft. of main line shafting, and a large number of countershafts and belts. All machinery used in the tumbling and rolling rooms, in the pattern and machine shops, and for operating elevators, fans for the cupola furnaces and for the ventilating systems, is now electrically driven.

Much valuable space was formerly taken up by the belts and pulleys used in the mechanical transmission of the power. Several of the pulleys were six feet in diameter, and in many cases it was impossible to locate the machines to the best advantage, owing to the necessity of placing them as near the main line of shafting as possible, to keep down friction losses. Such losses amounted to about 85h.p., as determined by indicator cards taken in anticipation of the introduction of electric drive. To step down the 2,200 volt local distributing pressure three 100kw. delta-star-connected type H transformers, giving 220 volts secondary between phases and 127 volts between each phase and the neutral, have been installed in a small brick building conveniently located.

The total motor equipment of the plant consists at present of thirty-nine 220 volt, forty-cycle, three-phase induction motors, aggregating 306.5h.p. and replacing 350h.p. in the two steam engines formerly used. All the motors have a rated speed of 1,200 revolutions per minute, except one 20h.p. motor which has a speed of 800 revolutions per minute All motors of 5h.p. and over, except the 5h.p. elevator motor, are started by the compensators equipped with oil break starting switches and fuses. A triple-pole, single-throw air-break switch is inserted in these motor circuits, enabling the compensator to be entirely disconnected from the mains for repairs, for making changes in the low-voltage taps, &c. The fuses and disconnecting switches for each motor are mounted on the wall in a protected wooden box, which is placed immediately above the starting compensator. The motors for elevator service have a high-resistance rotor to give high starting torque.

None of the motors are inverted, but all of them are placed on platforms mounted overhead on the trusses forming a part of the building structure. This arrangement facilitates inspection, and the weight thus carried by the trusses does not exceed that of the shafting, pulleys, &c., that have been displaced by the introduction of electric drive.

In deciding upon the size of the motors to be used in group drives, the basis of calculation for each group was the horse-power necessary to drive the maximum number of machines, in the group, that would be in operation at one time. The grouping was arranged to accommodate not only the existing lay-out of machines, but also the progression of the work through the shops. No attempt was made to duplicate apparatus or circuits to provide for breakdowns, except in the case of the furnace fans.

By the introduction of electricity into this plant the expense for power has been reduced 30 per cent., while the convenience and economy of manufacture have been greatly improved, and valuable space reclaimed.

A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

Three Phase Traction Again.

By MERCURIUS.

WHEN Finzi made what is now that historic experiment with one phase commutator motors at Milan the doom of the three phase traction motor was sealed. At least it was said to be sealed, but it wasn't and isn't. The Valtellina line is still running and the Ganz Company are doubtless enjoying the discomfiture of London's Underground in getting its new trains into service. Naturally they could have done better—much better; indeed, whispers might perhaps be heard that electrification, without vexation, would have long since been possible had things been different, but *dis aliter visum*, and the Ganz Company can now relish the joke. It must not be supposed that they are contented with mere hilarity. That is but their pleasant side. They are ambitious, and, like Brutus, have their Cæsar in view. He succeeded in escaping them in the forum of Westminster, but they have tracked him to his lair in Columbia, and at the time of writing are pressing him hard at Asheville (where the A.I.E.E. enjoy their twenty-seventh annual siesta). Truly the ways of conspirators alter not. How soon, we wonder, will *et tu Brute* again fall from the lips of a slain dictator?

These are the signs as I read them. The Ganz Company have now carried the war into the enemy's camp. America, even though thou art as the tyrant Cæsar of old (and hast saddled us with the third rail), be true to thy faith in commutator motors, whether they be operated by direct or alternate currents, and don't even be tempted! Remember the Metropolitan!

At Asheville, just mentioned, the American Institute held its twenty-seventh annual outing, and among the twenty-seven papers read are two which must be as the writing on the wall to the Belshazzar of American electric railway engineers. Naturally I can't give his name. These papers were read by two of the conspirators. Mr. F. N. Waterman had visited the Valtellina line and at once became charged—not statically, but statistically—with a mission to convert his benighted countrymen. What have they allowed to stand between them and three phase traction? he seems to cry. Only an air gap! Nothing to do with two overhead wires at all! These trifles have all been overcome at Valtellina, and that air gap must not separate us from polyphase traction a day longer! Mr. L. C. de Muralt, a convert, is the other conspirator. He puts all the systems up together like skittles, and careful bowling leaves him with polyphase on its three legs. One phase commutator motors and motor generator combinations survived only a few shots, and although direct current stolidly withstood the fire, not even the weight of its rotary converters could save it. Mr. Muralt then retired, leaving his idol standing. To him that other overhead wire did not matter in the least. You want men out on the line ready for emergencies, and two wires will keep them busier than one; in fact, it will much improve their load factor—they need such little amusements.

Then what has happened at home and after the Metropolitan, too? Following that eventful encounter the Ganz Company invaded Scotland, which is Edinburgh, and have now begun the conquest of Wales. Soon we

shall see the steep heights in Snowdonica plied with polyphase trains, and then the standard will doubtless be planted nearer the Metropolis. But there, what else could one expect from Scotland and Wales, neither of them like America? The Editor is, I believe, sayinɡ something serious on three phase traction this month, but personally, I find every language, except Scotch, fails utterly to adequately express my feelings, so I will refrain from further remark.

The Economics of Three-Phase Traction.

THE United States of America are to have a bad attack of polyphase traction, as the Ganz Company, of Buda Pest, have arranged with a New York firm to exploit their system "across the herring pond." "Mercurius" has attempted a little satire on the situation this month. There is, however, every appearance of a serious campaign for three-phase traction "over yonder," and the reading of papers on the subject at Asheville, the meeting place of the A.I.E.E. this year, is strikingly coincident with the formation of the new company to exploit the system. The author of one paper is a consulting engineer of the newly-formed concern. The papers read are full of interesting and valuable data, comparing the various systems now suggested, but their extreme length precludes our publishing an abstract. We are, however, by the courtesy of the *Street Railway Journal*, enabled to present its editorial comments on the matter to our readers. These remarks will well repay careful study, and are worth assimilating:

It is rather singular at this particular time, when so much of interest is centred in the new single-phase railway motors, to find two convention papers at the American Institute joining in strong advocacy of three-phase induction motors for not only heavy railway work, but for that severe suburban class of work which requires peculiarly rapid acceleration. The predilection of many European engineers for this class of apparatus doubtless has its origin in the sentiment voiced by Mr. de Muralt in saying: "The three-phase, alternating-current motor is probably the most robust and thoroughly mechanical piece of electrical machinery extant." Most engineers who are familiar with three-phase working will probably join in this conclusion, but the distrust of multiple trolley wires is so strong in this country as to outweigh many real or supposed advantages. Mr. de Muralt takes up especially the case of adapting electric traction to the miscellaneous work of ordinary railroading, and fortifies his position by a detailed study of the equipment of a particular road investigated recently with electrical haulage in view. The road taken had 224 miles of single track, excluding sidings and including an ore road 49 miles long. It is, on the face of things, a case where the three-phase system, or any other able to carry a high voltage upon the working conductor, should have a considerable advantage in first cost of installation. It is therefore not altogether surprising to find the three-phase system some $900,000 to the good, as against the third-rail system fed by rotary converter stations. It must be noticed, however, that Mr. de Muralt counts on converter stations every ten miles, which, although this spacing gives at times excessive drop, is rather closer than would generally be expected. Maximum economy on either system would probably call for a different schedule from that assumed, but every change towards this would lower the actual difference in costs, while leaving their rates substantially unchanged.

Even allowing for this difference, the d.c. system is much the more costly, as necessarily results from the low voltage and heavy loss in the working conductors. For the same reason the d.c. system is at a disadvantage in efficiency and general operative economy. Speaking broadly, any system that uses 5,000 volts on the working conductors must win out in economy over any system using a few hundred volts, supposing the motors to be anywhere nearly at equality. We wish, however, that with this same road Mr. de Muralt had worked out the equipment with single-phase commutating motors, and with locomotives equipped on the Ward-Leonard system, both of which he discusses briefly, the former with some severity, the latter with qualified approval. However, these two systems require different plans of operation, the former working to advantage with many and short trains, the latter with longer trains, so that a comparison could with difficulty be made fair to both. Mr. de Muralt takes up at some length the objections commonly urged against the three-phase traction, and basing his judgment on

actual results obtained abroad, is inclined to think them hypercritical. He particularly calls attention to the fact that in relatively slow acceleration the three-phase motor requires less current input for the required torque than the corresponding d.c. motor, so that in actual practice an acceleration of 0.5 per mile hour per second is obtained in three-phase motors with current only some 20 to 25 per cent. above full-load running current, and he also holds that for higher accelerations favourable results can be attained. As to the overhead work, Mr. de Muralt holds that the somewhat increased line repairs of a double trolley line are more than offset by the relative immunity from motor repairs in case of induction motors, so that upon the whole, the total repair bill is likely to be lessened. On this point few American engineers will agree with him, but, on the other hand, few American engineers have personal knowledge of three-phase traction, as practised abroad, and of these few at least a sturdy minority agree with the judgment here indicated. We must confess, however, to a desire for more detailed information as to these multiple trolley wires in everyday use.

Mr. Waterman's paper takes up an entirely different phase of the subject—the application of three-phase motors to fast suburban work where very stiff acceleration is a prime necessity. This is the field generally held to be peculiarly adapted to d.c. motors. Mr. Waterman, however, takes up the very hypothetical case assumed by Mr. Berg in his well-known paper on the subject, read some years ago before the A.I.E.E., and shows the change made in the results by the suitable design and use of the motors. In particular, he shows that with proper choice of the rate of acceleration, leaving the schedule unchanged, the results postulated by Mr. Berg for d.c. motors can be bettered with three-phase motors so as to gain some 12 per cent. in cost of equipment and nearly 4 per cent. in energy required. It is quite possible that a slight change in the schedule would change these figures, but the intent of Mr. Waterman was to adhere rigidly to Mr. Berg's schedule. We note that Mr. Waterman lays stress on the importance of the ability of three-phase motors to return energy to the line in braking. This is a much-debated matter, and in this country, at least, the gain has been considered of doubtful expediency, certainly in the case of motor systems other than three-phase. Some experiments made by Mr. Waterman on the Valtellina line showed that nearly 60 per cent. of the total energy expended on a long grade was recovered on the descent, surely an amount worth considering. The grade in this instance was 1.8 per cent., which shows at least a possibility of good results on certain lines. Mr. Waterman also calls attention to the curious result when the generator speed falls slightly on the Valtellina line. The immediate effect is to cause return of energy from all motors initially running near synchronism, so that each train acts as a flywheel to soften the effects of sudden changes of load. The result at the station is stated to be most conspicuous.

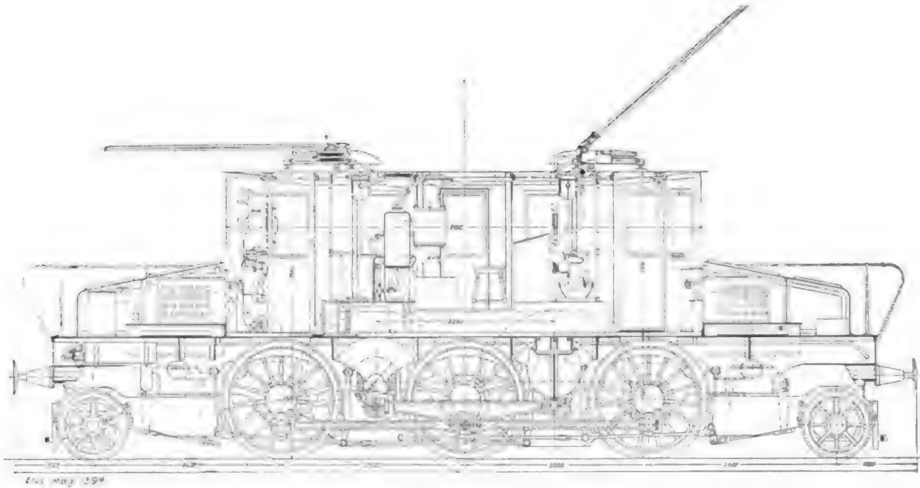
Altogether, these two papers are very powerful pieces of special pleading well adapted to arouse renewed interest in three-phase traction at a time when the current of popular opinion was setting in other directions. Current practice here has set itself firmly against any method of working requiring more than the one working conductor, which is accepted as a necessary evil. This is really the vital point in any such discussion, and we much wish that someone could and would give us a detailed and unbiassed account of the working of the overhead system on the Valtellina Railway with a bill of repairs for the last fiscal year.

New Valtellina Locomotives.

THE renewed attention now being paid to polyphase traction lends interest to a description recently published in the *Electrical Review*, N.Y., of a new type of locomotive running on the celebrated Valtellina line. We append a few particulars taken from our contemporary.

The locomotive is carried on two four-wheel and one two-wheel trucks. The four-wheel trucks are at each end of the locomotive and each consists of a pair of driving wheels and a pair of leading or trailing wheels. The four-wheeled trucks are swivelling. This construction has been tried by the Southern Italian Railway in twenty steam locomotives, which have been found to take easily the sharpest curves, and run quietly at the highest speeds.

In the attached view of the completed locomotive, it will be seen that the two motor cranks are connected together by a side bar which drives the crank of the central axle. To this side bar the cranks of the two outer driving wheels are connected by side bars. The crank-pin box of the central axle is



SIDE ELEVATION OF NEW VALTELLINA POLYPHASE LOCOMOTIVE.

allowed vertical play in the motor connecting-rod head because the motors are spring-suspended. The crank-pins of the motors have spherical bearings, on account of the play allowed.

The collecting device designed in 1901 for the first locomotive has proved so satisfactory that but slight changes have been made in it.

The locomotive is equipped with two motors. Each is a double machine having high-pressure and low pressure rotor and stator windings. Each stator is supported by four rods with spiral springs between the heads and the stator lugs. The rotor is held central by self-oiling bearings in the stator, but there is no force exerted on these bearings other than that due to the weight of the rotor. For convenience of inspection, the rotor slip rings are supported by a return crank outside of the driving crank. The wires from these rings are led into the rotor through an opening in the return crank, through the hollow crank-pin, back through the driving crank and the hollow shaft. This arrangement, in addition to its convenience for inspection and repairs, enables the entire space within the truck to be devoted to the motor proper, making possible the use of a larger machine than would be the case were the slip rings placed between the rotor bearings. The brushes are of carbon, and are carried on a frame supported from the motor axle. This frame and the slip ring are enclosed in a sheet-iron housing, which is opened along a central line, swinging both ways, leaving free access to the brushes and rings. The windings are carefully insulated, it being required that they be submitted to a testing voltage five times the normal. They were tested at 15,000 volts.

The specifications required that the locomotive should develop 800h.p. when running at sixty kilometres an hour and that it should develop 1,200h p. for one hour, and 1,600h.p. for a short time. Another requirement was that the locomotive should bring a 400-ton train up to thirty kilometres an hour in fifty-five seconds on a straight track with a grade of not more than 0.1 per cent. It should also bring a 250-ton train from rest to sixty kilometres an hour in 110 seconds on the same grade. The locomotive should drag a train of 250 tons up a 2 per cent. grade, and bring it to forty kilometres per hour. These performances should be obtained with a line voltage of 2,700.

The liquid rheostat of the earlier locomotive has so many advantages that this type was adopted for the new machine. The water rheostat consists of an outer sheet-iron containing-vessel, within which is a second cylinder open at the bottom. The rheostat plates are suspended within this inner cylinder. The outer cylinder is closed at the top, and compressed air is admitted above the liquid. This forces down the surface of the liquid in the outer vessel so that it rises within the inner and establishes a circuit between the three electrodes. The higher the surface of the liquid within the inner cylinder, the lower the resistance; and when the level liquid has reached a definite point, the rheostat is automatically short-circuited by a metallic switch.

The rate at which the liquid rises within the inner cylinder of the water rheostat is governed by a controlling valve, which is regulated by the current flowing into the motors. The air supply to the rheostat is controlled by a double diaphragm valve, to which air is admitted inside and outside. There is, in addition, an electromagnet which controls the opening of the valve. When the master controller handle is moved through one notch, this valve is opened and air admitted, at a rate depending upon the load, to the water rheostat. The

water then rises until a definite position is reached, when it stops. Further movement of the controller handle admits more air, and raises the level of the water again and so on until the rheostat is short-circuited.

An interesting comparison was made between this locomotive and several high-duty steam locomotives belonging to the Rete Adriatica. These vary in total weight from 92 to 108.55 tons. The electric locomotive complete weighs sixty-two tons. The tractive load of the steam locomotives varies from 42 to 43.5 tons; that of the electric locomotive is 42 tons. It is computed that, with velocities of thirty-one kilometres per hour, the available draw-bar pull of one of the larger steam locomotives will be 350 tons on a 1 per cent. grade, and 152 tons on a 2 per cent. grade. The electric locomotive, on the same grades, will give 460 and 250 tons respectively. At velocities of sixty-four kilometres per hour, the same steam locomotive gave draw-bar pulls of 207 and 68 tons on 1 and 2 per cent. grades respectively. The electric locomotive would give 270 and 90 tons under the same conditions. The difference in favour of the electric locomotive, therefore, varies from 30 to 64 per cent.

This locomotive was constructed for hauling passengers and express matter—not for freight. On this account it was necessary to add the two pony trucks to secure quiet and safe running. Had the locomotive been designed for freight, a fourth driven axle would have been supplied in place of the two pony trucks. If the locomotive had been constructed on this plan, the traction load would have been 56 tons, and assuming an adhesion coefficient of 20 per cent., a drawbar pull of 11,000 kilogrammes would be obtained.

New York Subway Dangers.

Mr. Nikola Tesla contributed an extraordinary letter to the New York *Sun* of June 16th, a few extracts from which are given below:

The flooding of the Subway is a calamity apt to repeat itself. It will never be possible to guard against a casual bursting of a main, for while the conduits can be safely relied upon under normal working conditions, any accidental obstruction to the flow may cause a pressure which no pipe or joint can withstand. In view of this it seems timely to call to public attention a danger inherent to the electrical equipment which has been thrust upon the Interborough Company by incompetent advisers.

It is to be regretted that this important pioneering enterprise, in other respects ably managed and engineered, should have been treated with such gross neglect in its most vital feature. No opportunity was given to myself, the inventor and patentee of the system adopted in the Subway and the elevated roads, for offering some useful suggestion, nor was a single electrician or engineer of the General Electric and Westinghouse companies consulted, the very men who should have been thought of first of all.

The danger to which I refer lies in the possibility of generating an explosive mixture by electrolytic decomposition and thermic dissociation of the water through the direct currents used in the operation of the cars. Such a process might go on for hours and days without being noticed; and with currents of this kind it is scarcely practicable to avoid it altogether.

It will be recalled that an expert found the percentage of free oxygen in the subway appreciably above that which might reasonably have been expected in such a more or less stagnated channel. The total amperage of the normal working current in the tunnel is very great, and in case of flooding would be sufficient to generate not far from 100 cubit feet of hydrogen per minute. Inasmuch, however, as in railway operation the fuses must be set hard, in order to avoid frequent interruption of the service by their blowing out, in such an emergency the current would be of much greater volume and hydrogen would be more abundantly liberated.

One hundred thousand cubic feet of explosive might be formed before the danger is discovered, reported, and preventive measures taken What the effect of such an explosion might be on life and property is not pleasant to contemplate. True, such a disaster is not probable, but the present electrical equipment makes it possible, and this possibility should be, by all means, removed.

Ventilation will not do away with the danger I have pointed out. It can be completely avoided only by discarding the direct current. I should say that the city authorities, for this if for no other reason, should forbid its use by a proper act of legislation. Meanwhile, the owners of adjacent property should object to its employment, and the insurance companies should refuse the grant of policies on such property except on terms which it may please them to make.

Mr. L. B. Stillwell, chief engineer of the Interborough Rapid Transit Co., had something to say in reply to this alarmist note.

It is possible that some of your readers who have read none of Mr Tesla's prophetic essays which have appeared from time to time during the last ten or fifteen years in the daily Press may attach weight to his opinion, and as the public is greatly interested in the Subway and its operation, statement of a few facts seems pertinent and proper.

He reiterates some of the statements contained in previous letters, and calls attention in the following words to a new danger which he

has discovered: "The danger to which I refer lies in the possibility of generating an explosive mixture by electrolytic decomposition and thermic dissociation of water through the direct currents used in the operation of the cars." His alternating-current polyphase system, as he says, would be free from this danger. Obviously, a charge so serious as this should rest upon a very substantial foundation of fact, and no consideration of self-interest or of personal animosity will excuse its author unless he can prove his charge. And what does Mr. Tesla offer as evidence that electrolytic decomposition of water is taking place in the Subway? He says: "It will be recalled that an expert found the percentage of free oxygen in the Subway appreciably above that which might reasonably have been expected in such a more or less stagnated channel." In other words, the Subway air contains more oxygen than Mr. Tesla expected, and upon this fact he constructs his theory of the production of oxygen and hydrogen gas by electrolysis. He does not offer in his letter a scintilla of evidence that oxygen is thus being set free. No one has alleged that the air in the Subway contains more oxygen than uncontaminated and free air. If Mr. Tesla, therefore, is comparing an actual analysis with anything more definite than his own notion of the kind of air that might be expected in the Subway, it is for him to make clear his reasoning.

Among all that Mr. Tesla has said upon the subject, three charges besides that relating to alleged excess of oxygen perhaps call for reply in order that any part of the public which may have been disturbed by his statements may be reassured. These charges are: (1) That a mistake was made in not adopting polyphase induction motors; (2) that "not a single electrician of the General Electric or Westinghouse Companies was consulted"; and (3) that "a mistake was made in not asking the electric companies to furnish the best instead of the cheapest equipment."

The management of the company aimed to secure the best system available, and no limitation in respect to cost was imposed upon its engineers. Apparently Mr. Tesla seeks to convey the impression that the polyphase induction motor system is more expensive than that adopted. As a matter of fact, the reverse is the case, the chief claim of the induction system residing in the fact that it is less expensive than the system which the Interborough Company has adopted. Several years ago, when tenders were submitted by manufacturers to the Metropolitan and District Underground Railways in London, the induction motor system was proposed by Ganz and Co., of Buda Pest, and the price asked was approximately two-thirds the average price of the competing tenders, which were based upon the system which has since been adopted for the New York Subway.

The responsibility for decision in respect to the system adopted rests primarily upon me, but the plans were duly examined and approved by Messrs. Duncan and Hutchinson, consulting electrical engineers to the Rapid Transit Commission. As regards consultation with electricians and engineers of the General Electric and Westinghouse Companies, I have been in touch with the leading representatives of both companies from the outstart of this work up to the present time. Many of these gentlemen have contributed largely to the success of the installation and operation of the electrical equipment, and, so far as as I am aware, are unanimous in believing that the best system available was adopted.

In support of his contention that a mistake was made in adopting the system which is in use, Mr. Tesla has offered simply an expression of his personal opinion. The polyphase motor system, as developed by Ganz and Co., of Buda Pest, undoubtedly has very strong points to commend it under certain conditions; and for what Mr. Tesla did in the early days of its inception the engineering world is under obligation, which in America has been fully recognised. Since certain United States patents were issued to him in 1888, however, he has done little, if anything, towards perfecting the motors, and still less towards the development of the multitude of other devices which in the aggregate constitute an electric traction system. Scott, Lamme, Steinmetz, Berg, and others in Pittsburg and Schenectady have developed and improved the induction motor so that is is now extensively used in stationary work; but it has never been used in America for traction purposes upon any scale which would have justified its adoption by the Interborough Company. In Europe, within the last five and six years, the engineers of Ganz and Co. have developed it for traction purposes, and under certain conditions they have demonstrated its value in this field. Possibly this fact explains Mr. Tesla's recently revived interest in the motor of this type.

Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

Lamps and Lighting.

National Electric Light Association Papers.

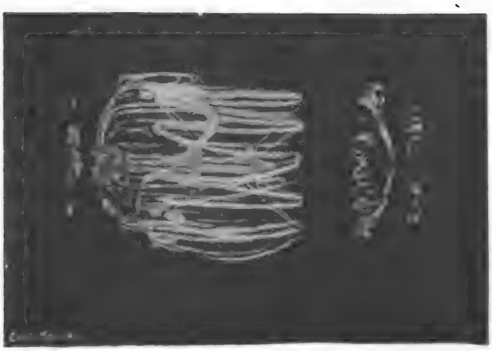
EVERY year the National Electric Light Association keeps up its reputation as a body dealing thoroughly with electric lamps and electric lighting. At this year's Convention, just closed, the papers read bearing directly on lamps and their application to lighting were numerous and important. Indeed, they are an object-lesson in compilation to our own engineers, who from time to time essay to give their views on the results of their experiments to their *confrères.*

The tantalum naturally received special attention, and Dr. Louis Bell, in conjunction with Prof. W. L. Puffer, had much to state of their experiments. A curious feature, to which attention was drawn, is the sagging of the filament when burning horizontally, and the authors thus remark on this peculiarity:

"The tantalum filament seems to stretch and sag at first as if undergoing annealing and losing the set produced by drawing. Then it shows local bright spots which grow lumpy, as if the material tended to flow a little from the heat, and with the increasing lumpiness the filament draws up tight. At this stage it is rather fragile and would probably break easily from vibration or shock. It seems likely that the final break comes just where one of the lumps has reduced the cross-section of the wire beside it. The break in the lamp already referred to showed considerable attenuation of the loose end during test."

The use of lamps consuming something like half the previous amount of energy raises an interesting problem for central station men, and Dr. Bell freely discusses these in his usual versatile manner. He deprecates any adjustment of discounts to discourage the use of the new lamps, and points to a similar situation once faced by gas interests on the introduction of the incandescent mantle. The situation is thus succinctly summed up in the paper:

"As to the inevitable competition between present lamps and the newcomer, in the first place, the merits of the final issue remain to be determined, and in the second place competition in lamps is, on the whole, a good thing for the user of them, however it turns out. So far as the central station is concerned, it is a case of dog eat dog. The really important thing is that from now on the station manager will have to deal directly with the 2-watt lamp proposition, for there is no disguising the fact that it is here, and in



TANTALUM LAMP SHOWN LIGHTED.

a form which is quite unexpected. The appearance of tantalum lamps in quantity may be a little delayed in this country, but delay will improve them as in the case of every new product, and will serve to assure a better understanding of their truly remarkable properties and of their possible limitations. The unexpected has certainly happened, for most engineers had long ago abandoned the idea of a lamp with a metallic filament. Only the discovery of a metal virtually new, and possessed of most sensational qualities, could have brought about the present striking result."

The value of electric signs, as was pointed out in our last issue, is appreciated and advantaged to the full in the States, and the remarks of Mr. L. Vredenberg in his paper on signs and decorative lighting are clearly indicative of this attitude. "The method pursued by one of the large companies last year was a persistent and systematic advertising campaign by means of letters, return postal cards and enclosed stamped envelopes, sent to a selected mailing list including all retail merchants in all lines of business whose stores were sufficiently pretentious to possess plate-glass windows. This campaign last year resulted in more than doubling the number of sign customers. The above result was obtained in a city where an ordinance restricts the projection of signs to two feet from the sidewalk line. Consequently, most of the signs installed are placed either vertical or flat against the face of the building. Most of the large companies use electric signs for their own advertising, thus proving their faith in what they recommend to others; the effect of this is undoubtedly in the right direction. A field that shows quite a promising crop for lighting companies is the illumination of bill-boards. These are generally controlled by advertising concerns, who are beginning to appreciate the increased value of their space when properly illuminated. This is also appreciated by the advertisers, for they realise that the illumination of a sign-board adds about five hours each day to its usefulness, and they are willing to pay for these five hours. Some of the lighting companies whose lines extend through country districts in reaching suburban towns are beginning to light the large bill-boards displayed along railroads and highways. This should be profitable lighting wherever the boards are within a reasonable distance of the company's lines."

Nernst lamps are enjoying a very wide use, and our American friends are very keen in collecting data about them. The figures of Mr. E. R. Roberts should be compared with those obtained by Mr. E. E. Hoadley, whose paper on Street Lighting is given in our Supplement this month. Mr. Roberts says, "The decrease in mean hemispherical candle-power amounted in 1,000 hours to 22 per cent., the greater part of which took place in the first 300 hours. The initial consumption per mean spherical c.p. was 3.31 watts and per mean hemispherical c.p. was 1.95 watts. At the end of 1,000 hours the values had increased to 3.78 and 2.27 respectively. It is stated that, while the Nernst lamp properly belongs to the class of incandescent lamps, from the maintenance standpoint it is more akin to the arc. From the reports of the 7,000 glower units in service in the Pittsburg district it is learned that the total maintenance cost per glower per month is 9.56 cents, and it is estimated that the cost for maintenance per kw.-hour of energy used is 5.2 mils. This figure agrees closely with the average cost reported by a number of companies who use the lamp on a large scale."

Note on the Use of White Walls in a Photometric Laboratory.

By EDWARD P. HYDE.

It is usually considered by photometricians that one of the essential requisites for accurate work in photometry is that the walls of the photometer room be made as nearly "dead black" as possible. It is surprising how long this tradition of photometry has persisted, particularly as it necessitates the exclusive use of a room for photometric measurements, since a room blackened in the customary manner is unfit for any other work. Perhaps it is due to this fact that one so often finds the photometric laboratory in a small room in the basement or garret, or some other place that is unsuited for any other purpose. In all open-flame work, however, much larger errors may result from poor ventilation in a small room than from light reflected from white walls of a larger room, provided a proper set of screening diaphragms is used.

So far as I know nothing has been published as to the magnitude of the error due to white walls when the photometer is protected by black diaphragms, although this arrangement

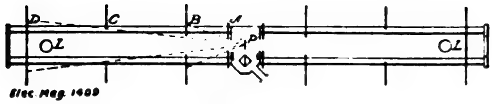


FIG. 1.

is at present in use to some extent in the photometric laboratory of the Physikalisch-Technische Reichsanstalt of Germany.

In the photometric laboratory of the Bureau of Standards the walls of one of the rooms, which is about 29ft. long, 19ft. wide, and 12ft. high, were left white for a year after the construction of the building. Recently they have been given a light terra-cotta finish for decorative purposes, but the following measurements were made while the walls were still white. The photometer is placed near the middle of the room and is supplied with a set of diaphragms covered with black velvet. These diaphragms may be so arranged for any position on the bar that no light, except that reflected from the lamps under test, or from the diaphragms themselves, can reach the photometer screen, as shown by the accompanying sketches. Fig. 1 is a horizontal section of the photometer through the centre of the Lummer - Brodhun sight - box, showing the arrangement of diaphragms *A*, *B*, *C*, and *D*. Elevations of these diaphragms perpendicular to the axis of the photometer are given in Fig. 2. By reference to Fig. 1 it is seen that an eye placed at *P* could see nothing but black velvet diaphragms and the lamps under test. Conversely, no light could reach the screen except from the lamps or from the diaphragms.

In case a Bunsen or Leeson disc is used, extra precautions would have to be taken to prevent light from penetrating to the screen from the front of the box. It is essential that this condition be fulfilled if the walls are to be left white, as any reflected light reaching the screen directly would materially affect the result. Furthermore, it is desirable that all outside light be excluded by the use of dark curtains, as under these circumstances the only light that can reach the photometer screen, apart from the direct light from the lamps, is that part of the light from the two lamps which is reflected by the walls back to the two lamps and to the diaphragms, and from them to the photometer screen.

In order to determine the magnitude of the errors resulting from this reflected light from the white walls of the photometer room of the Bureau of Standards, the measurements described below were made. The results of

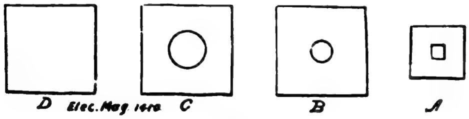


FIG. 2.

these measurements show conclusively that the error is entirely negligible.

In making the measurements of the effect of reflection from the walls, the right side of the photometer was entirely protected from reflected light from the walls by large screens which nearly surrounded that half of the photometer bar, so that when the left side of the Lummer-Brodhun sight-box was closed by a shutter, no illumination was visible in the eye-piece. The velvet-covered diaphragms and the lamp on the left side of the photometer, on the contrary, were left exposed to the reflected light from the walls, as in the ordinary method of measurement, except that the lamp on that side was not burning. Therefore the only light that penetrated to the screen was that which, reflected from the walls, fell upon the lamp and black velvet diaphragms and was reflected by them to the screen.

In order that the walls should be illuminated to the same extent as in the ordinary measurements, a 16c.p. lamp was burned near the position of the comparison lamp, and another lamp was burned near the position of the standard lamp, but so shielded in each case that no direct light could reach the photometer. The lamp on the left near the unburned standard was changed from time to time from a 32c.p. lamp to a 16c.p. lamp, depending upon whether a 32c.p. unburned lamp was in the left socket at the distance from the screen at which a 32c.p. lamp is usually placed, or a 16c.p. lamp was in the socket at the position used with a 16c.p. lamp. These precautions were taken in order to have the conditions as nearly like the actual conditions as possible.

Under these circumstances it was perfectly plain, on looking into the eye-piece of the photometer, that the left side of the sight-field was slightly illuminated, and it only remained to measure this illumination under the different conditions likely to occur. To this end a 1c.p. lamp, which had been placed on the carriage on the right in the position of the comparison lamp, was brought to incandescence, and the light from this lamp was cut down by absorption strips of smoked glass, having known coefficients of transmission. Thus, successive absorption strips were added until a balance was obtained, and the number of strips and the positions of the three carriages were recorded.

These measurements were made with the windows covered with heavy curtains, the only sources of illumination of the walls being lamps similar to ones that would ordinarily illuminate the walls when making photometric measurements. When the curtains were raised the effect was greatly increased, so that the error in a 32c.p. lamp was several tenths of a candle, varying with the brightness of the sky and with the distribution of objects about the room. Approximately the same relative error was found for the 16c.p. lamp, so that in comparative measurements the errors in general would

be negligible, but since the errors of measurement of these corrections were necessarily large, and since we found the corrections to vary considerably when an observer moved in front of a window, it is desirable to exclude daylight by curtains, as there is a possibility of error even in comparative measurements with the substitution method when such large absolute errors occur.—*Electrical World.*

Rare Metals for Illuminant Purposes.

By GEORGE E. WALSH.

THE problem of improving methods of illumination through the employment of certain rare metals and ores is one that has been steadily simplified in recent years, and the solution of the question appears to be largely a matter of substituting better and more satisfactory mineral elements or earths for the older ones used. Constant experiments conducted in laboratories indicate that investigations along this line are progressing rapidly and that the future economy and value of such illuminants as the arc and incandescent lamp, Nernst lamp, Welsbach mantle, and the mercury-vapour lamp depend to a large extent upon the rare earths and minerals employed in their manufacture.

Selenium, for instance, is recognised as an important factor in the development of the electric lamp, for as a means for measuring the luminosity of rays it proves of great value. Selenium responds principally to the luminous rays and not to the heat rays or the chemical rays, consequently its use in photometric studies and experiments is rapidly increasing.

In the manufacture of the Nernst lamps, zirconium oxide and yttria are employed in the proportion of 85 per cent. of the former and 15 per cent. of the latter. This mixture was the result of years of close experiment with magnesia, thoria, ceria, and other substances. The combination of zirconium and yttria into a substance which conducts electricity at certain temperatures, and which vaporises very slowly, has added greatly to the development of modern electric lighting by the Nernst lamp method.

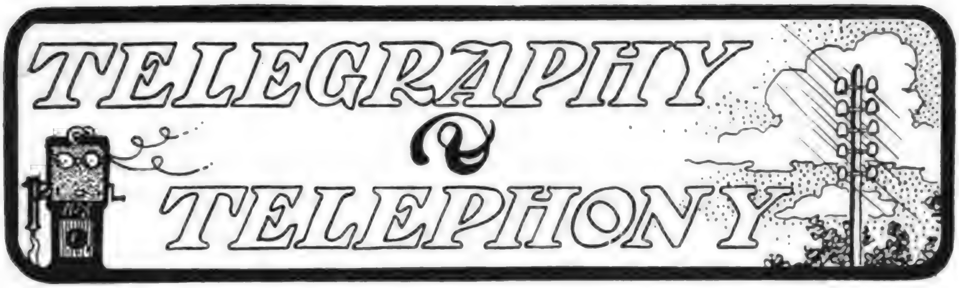
The early glowers were made from zirconia obtained from chemical supply houses, but this was inferior and impure, giving very uncertain results. It was only when deposits of good zircon ore or a zirconium silicate were found in North Carolina that the efficient glowers of to-day could be manufactured on a commercial scale. The ore found in Henderson County, in North Carolina, contains upwards of 67 per cent. of zirconium as oxide, and by treating this ore almost pure zirconium is obtained. The ore is ground very fine and fused slowly in a graphite crucible, after which it is chemically treated to remove all traces of iron and other impurities from it. Absolutely pure zirconium is not obtained by this process, but it is sufficiently pure for all commercial purposes. The mining industry for the ore has grown extensively in recent years, and with the development of the gas mantles and Nernst lamps the demand for the ore is rapidly increasing.

Yttria, which is combined with zirconium to produce the glower of the Nernst lamp, is obtained from gadolinite, fergusonite, rowlandite, and other rare minerals. Nearly all of the yttria earths were obtained until a few years ago from Norway and Sweden, where they were found mixed with gadolinite. The discovery of a rich deposit of these earths in Llano County, Texas, immediately attracted the attention of manufacturers. The domestic ores were found to be superior to the foreign, the atomic weights of the former ranging from 100 to 115, and the latter as low as from 90 to 92. The yttria earths having the greatest atomic weights prove the most valuable for illuminant purposes.

The deposits of yttria earths in Texas are supposed to be of volcanic origin, and the district in which they are found is comparatively small. Extensive examination of the neighbouring regions have so far resulted in no discovery of new deposits. Reports have indicated that the ores may be found in portions of the West, but so far no exact area has yet been marked where deposits can be located. The Texas deposits are radio-active, and their presence in the quartz is indicated by slight radiating discolorations. In Texas the earths are found in varying proportions in crystalline form associated with the other minerals.

In Europe the rare earths have been experimented with in connection with electric arcs more than in this country. Some of the rare-earth oxides have been used for electrodes entirely. Considerable advances have consequently been made in the introduction of these earths, and also such elements as boron and tantalum. These latter have been introduced in the electrodes with varying degrees of success.

Nearly all the rare-earth oxides possess some of the desirable properties for illuminating purposes, but their value from the miner's point of view cannot be great until they have come into commercial use, either alone or in combination with other substances. The field of experiment is thus broad and attractive, and scientists and engineers may find new uses for many of the earth oxides that to-day are worthless.—*Western Electrician.*



For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

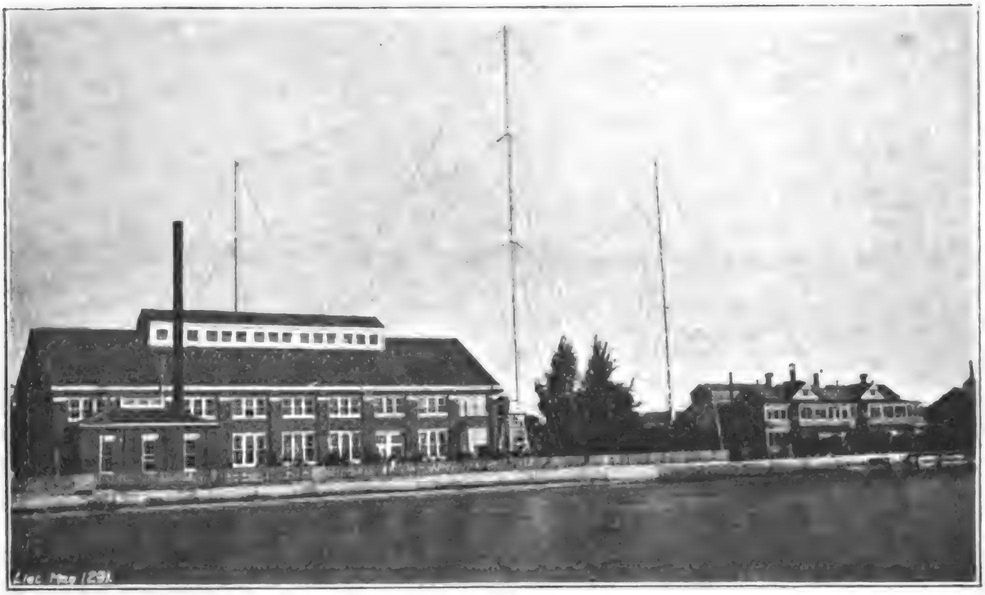
Wireless Telegraph Developments in the United States.

By Dr. LEE deFOREST.

THE United States Navy granted the American deForest Wireless Telegraph Company bids under competition for the erection of five of the largest stations in the world, to be located at Pensacola, Florida; Key West, Florida; Guantanamo, Cuba; San Juan, Porto Rico; and Colon, Panama Canal Zone. The idea was to connect these naval stations by means entirely independent of the cable, so that in time of war there could be no interruption of service. The Government deem this move of high strategic importance, and the enthusiasm and elaborate method with which the navy has gone into the matter of these wireless telegraph stations shows how serious they consider the proposition. Four of the stations are for distances of 1,000 or 1,200 miles, and call for equipment of 35kw., nearly 50h.p.

The Pensacola station is of 10kw. capacity only, and is intended to work to Key West, a distance of 450 miles. The deForest Company guaranteed to equip these stations within a year to maintain communication between them for thirty days, at the end of which time they will be turned over to the United States Navy operators. Arrangements were entered into with the navy whereby, under certain conditions, the deForest Company could use these stations for the handling of commercial business, the navy agreeing not to operate the stations for commercial business in competition with the existing wireless telegraph stations of the deForest Company. At the four large stations, which, by the way, excel in power any in the world, are three masts. These masts are of the openwork built-up style similar to what was seen on Art Hill at the World's Fair. The masts are placed at the corners of equilateral triangles 300ft. apart, and the station house is located in the centre of the triangle. Horizontal stay cables run between the tops of the masts, and fifteen wires depend from each cable, making forty-five wires in all. These wires are led out from the line of the masts and there held by cord guys, from which point they lead inwardly to the house located at the centre of the triangle. In

UNITED STATES NAVY STATION, PENSACOLA.

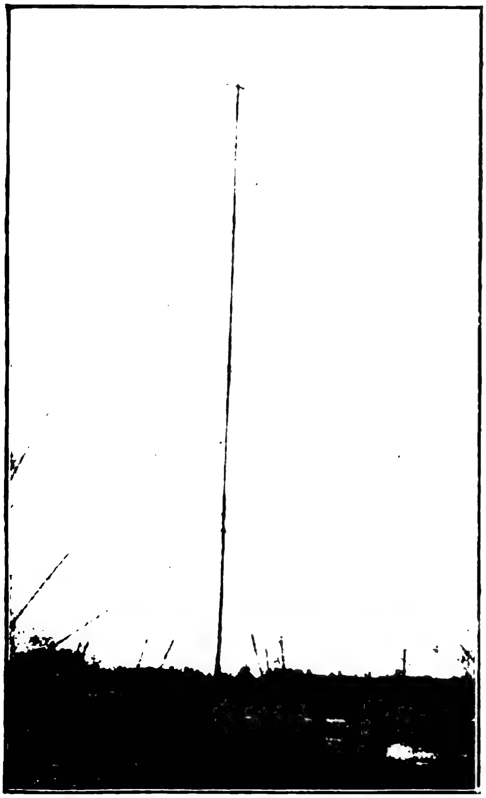


DeForest Wireless Telegraph Station at Key West.

this way each wire is over 300ft. in length and the aggregate exposure is so enormous that the length of the wave sent out from these stations is over a mile. These are by far the longest waves ever used in wireless telegraphy. The long wave, it is found, is desirable for long distance transmission, as it represents a large amount of energy and has the ability to overcome obstacles, rounding hills and mountains with a far less diminution of energy than is possible from the shorter wave-lengths. The Pensacola station, as will be seen from the photograph, is equipped with only two masts. These are 180ft. high, 200ft. apart. A single screen of fifteen wires hangs down from these two masts.

The station at Key West is located right in the town, and a magnificent grove of sixty cocoanut palms had to be felled to allow the erection of the masts. The city of Key West covers less than half a square mile of area; and at night, when this powerful station is in operation and the spark of the transmitter is unmuffled, its sound can be heard like the rattle of musketry in any part of the city. Thirty-five kw. of energy at a potential of 25,000 volts, discharging at the rate of sixty times a second across this spark gap, gives one a sensation of tremendous power and might of electricity obtainable under no other circumstances. The spark gap is enclosed in a double-walled casket with glass doors and the entire transmitter placed within a small room. When all these doors are closed the sound is scarcely noticeable outside of the building, but when one is locked up within the transmitter room, and all the doors of the muffler open, the intensity of the sound is positively terrifying. One feels his whole frame rocked at the pulsations of the air. The spark is of the most intense brilliancy and exceedingly dangerous to the eyes to look upon. It is no uncommon thing to experience a ringing in the ears for twenty-four hours after two minutes' interview with the unmuffled spark within the closed room.

An idea of the intensity of radiation sent out from this spark may be obtained by watching the lofty antenna wires at night. Moonlight in these subtropic regions is of unequalled intensity and brilliancy, yet on the brightest moonlight night the observer standing near the foot of one of the masts may see the antenna wires extending far into the blue vault above outlined in glowing fire; and on a dark, cloudy night the illumination from the antenna seems to light up the heavens, while the wires split and crackle like the fire of brushwood with every depression of the key. As one operator graphically



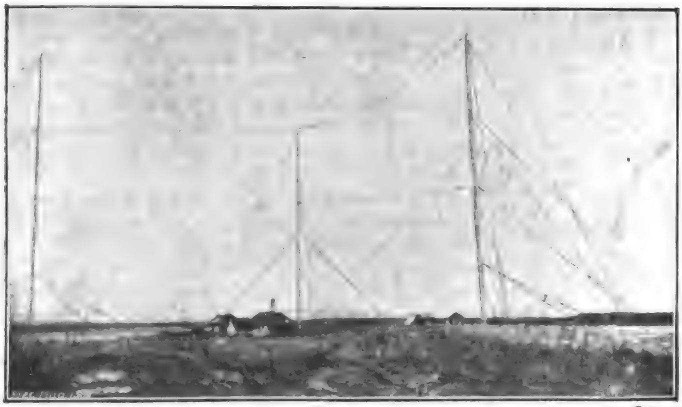
15KW. STATION AT CHICAGO.
(There are two other Stations in this district.)

expressed it: "The electricity is actually burning a hole in the air to get away from there." No one can witness this spectacular phenomenon without feeling satisfied that the vibrations radiated out must be travelling to the very ends of the earth, and they do seem to extend pretty well in that direction. The Key West station was opened early in February, and during the first week of its operation messages were exchanged with the deForest station at Chicago and Cleveland, a distance of nearly 1,500 miles.

At Kansas City and Chicago, pictures of which stations are included, the equipment is of far less power than at Key West, being only 15kw. Yet at night the signals from these two stations are received loudly from the great stretch of wire which the masts at Key West support.

The distances of transmission at night are sometimes twice as great as those attainable in the daytime. Hence the longest distance work is always best accomplished after sunset, but the power at Key West and other deForest naval stations is ample to allow transmission of 1,000 to 1,500 miles in the brightest daylight. Another photograph shows the station at Guantanamo, South-East Cuba. The United States Navy has leased this for a long term of years from Cuba as a coaling station, and about the only work which has yet been done on the place is the erection of the mammoth deForest Wireless Telegraph Station. A lonely, desolate, inaccessible promontory jutting out in the giant harbour of Guantanamo was cleared of its tangled underbrush and mangrove, and the wireless telegraph station located here. Access is only possible by means of the navy launches and barges, and the construction work is carried on in the face of greatest difficulties. The insects which make life in South Cuba a nightmare seem to have selected this wireless station as a general rendezvous and add to the pleasures of life in this desolate spot. One navy operator was sent to the ship's hospital

15KW. STATION IN KANSAS CITY.



United States Navy Station, Guantanamo. 35kw.

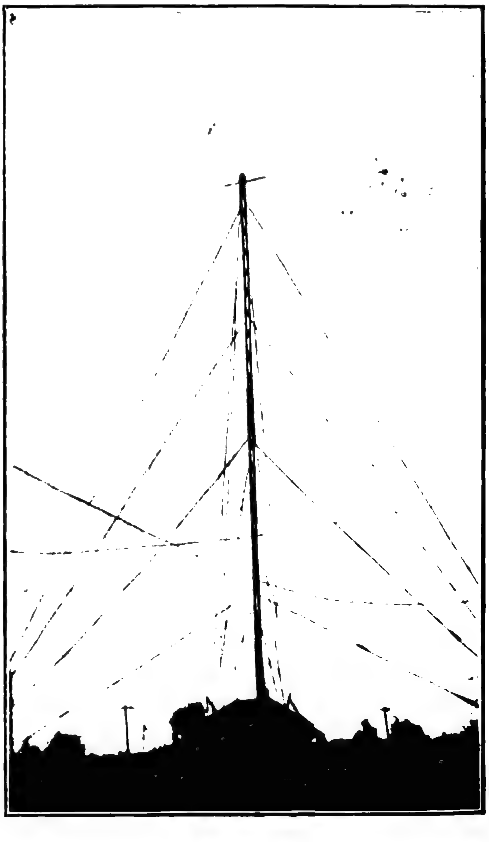
the Government station at Colon and should prove of the utmost commercial value. The present cable service to Colon is very unsatisfactory, and a rate of eighty-nine cents per word is intolerable. The committee from the New Orleans Board of Trade which recently investigated conditions on the Isthmus reported urgently the advisability of encouraging wireless telegraph connection between their city and the Isthmus to replace the exorbitant service now charged by the cable company.

(Mr. L. H. Walter's Article will be concluded next month.)

as a result of his fleabites, and the surviving members present a ring-streaked and piebald appearance. They sleep in ship's hammocks strung to the top of the engine house to get away from the carnivorous pests, and it is not uncommon for one to find upon awakening that a huge land crab has been his unwelcome bedfellow during the night.

The Guantanamo station is nearing completion, and the deForest experts are busy at work installing apparatus at Colon and Porto Rico. Satisfactory tests have already been made between Key West and Pensacola, and it will be but a month or two before the other three of these record-breaking wireless telegraph installations are pouring forth their energetic disturbance into the ether. The Bureau of Equipment of the navy requires of the deForest Company not only to operate over this enormous distance, but to keep in touch with the warships equipped with the deForest apparatus anywhere within the zone of influence of these stations. Inasmuch as the Key West station has already operated to New York, this zone of operation will cover all the South Atlantic, extending from New York eastwardly a distance of 500 miles or more, making a wide détour around Porto Rico and reaching South America upon the northern coast of Brazil, completely including the Caribbean Sea and extending far out into the Pacific Ocean around Panama.

The deForest Company has nearly completed at New Orleans another powerful station for their own private commercial operation. This will be in connection with



20kw. Station, St. Louis.

Telegraphy Correspondence Class.—VI.

Conducted by CICERONE.

THE fourth exercise has resulted in very creditable work by the most industrious of our students, but there is a regrettable absence of answers from some very promising competitors! Can it be that the fine balmy weather has produced this lethargy, or are the delinquents more keenly interested in holiday making than in the study of technological subjects? Surely when they recognise the additional inducement to study offered by the proprietors of the magazine, in the shape of valuable prizes, they will continue with renewed vigour the course they so encouragingly commenced. Their chances of success are still hopeful if they diligently apply themselves to the questions dealt with in future numbers.

An appeal is also made to the vast number of readers who are undoubtedly making a study of these papers, but who have not enlisted in the highly beneficial task of answering the problems in their own words. This little duty is more than half the education. It trains them in the art of expressing themselves lucidly and accurately, and it also aids the memory much more than is done by simple reading.

Let all telegraph students, while bearing this in mind, make an endeavour to keep apace with the series, and they will soon find their efforts bearing fruit.

"Pelmar" and "Treyar" have each submitted excellent solutions to the several questions, and "Nephalist" also displays a resourcefulness and originality of a high order. The first question has elicited some good definitions of electric potential, quantity, capacity, induction, and dielectric capacity. From them the following are culled, and a few explanatory notes added where deemed necessary.

Electric potential is the power to perform electric work. It is analogous to the head of water in hydraulics, or to the gravitational energy stored up in a weight that has been raised from the ground. An electric conductor can be charged to a potential so great that a disruptive discharge will take place between it and another conductor placed within its sphere of influence. This is what is meant by potential in electrostatics; but all metals, when placed in oxidising, sulphating or chlorodising media, have a certain potential, or power to do work, depending upon the nature of the metal. Potential difference is the expression used in voltaic electricity to indicate the electrical pressure or electromotive force existing between any two dissimilar metals when immersed in an electrolytic solution. This force, or potential, is measured in terms of the volt.

Unit quantity of electricity in electrostatics is that quantity or charge given to a conducting surface of unit capacity by unit potential. In voltaic electricity it is the quantity that flows through a conductor of unit resistance having unit potential applied to it: that is, the quantity flowing through a resistance of one ohm at a pressure of one volt, and is measured in terms of the coulomb.

Electrostatic induction, sometimes termed influence, is the influence exerted by an electrostatically charged body upon other bodies in its neighbourhood, the influence depending upon the potential to which the charged body is raised, the distance between it and neighbouring bodies, and the nature of the medium or the dielectric across which the influence takes place.

Dielectric capacity, or specific inductive capacity, as it was formerly called, is the capacity of any substance to allow electrostatic induction to pass across it. It is measured by comparison with dry air of similar dimensions.

Electrostatic capacity is the capacity of a conductor for accumulating or retaining upon its surface an electrostatic charge of electricity. It is measured in terms of the farad, which is the capacity possessed by a conductor capable of being charged with unit quantity of electricity at unit potential; that is, a conductor that will contain one coulomb at a potential of one volt. For practical purposes the unit is only one-millionth of the farad, and is called the microfarad.

Space will scarcely permit reference to be made to all the misconceptions entertained regarding these several quantities, nor can specimen errors be quoted, but from the foregoing notes competitors will be able to discover where they have erred. The second part of the first question does not entail so much writing in solving. The quantity, Q, of electricity residing on a body having 10 microfarads when charged to 50 volts is .0005 coulomb, since

$$Q = K.\,V.$$

$$= 50 \times \frac{10}{1{,}000{,}000} = .0005.$$

Question II. can also be easily solved from the formulæ and notes already supplied.

Twenty miles of wire 90 mils in diameter and 12ft. above the ground has a capacity of 1mf.: what is the capacity of 200 miles of 180 mils wire 20ft. above the ground?

From formula $K = \dfrac{l\,d\,s}{4h}$

$$\frac{K_1}{K_2} = \frac{\dfrac{l_1\,d_1\,s_1}{4h_1}}{\dfrac{l_2\,d_2\,s_1}{4h_2}}$$

Therefore $K_1 = K_2 \dfrac{l_1\,d_1\,s_1\,4h_2}{l_2\,d_2\,s_2\,4h_1}$

$$= \frac{1 \times 200 \times 180 \times 4 \times 12}{20 \times 90 \times 4 \times 20} = 12\text{mf.}$$

The dielectric capacity, s, being air in each case, may be neglected, and for comparative purposes the 4 in the denominator may also be deleted, so that the formula may be simplified thus :

$$K=\frac{l\,d}{h}$$

$$\therefore \quad \frac{20\times 0.09}{12} : 1 :: \frac{200\times 0.18}{20} : x$$

$$x=\frac{\dfrac{200\times 0.18}{20}}{\dfrac{20\times 0.09}{12}}=12\text{mf.}$$

In order to reduce this capacity by 50 per cent., *i.e.* to 6mf., as is involved in the second half of the question, how high would the wire have to be raised?

Let h = height required.

Then since $l\,d\,s$ is the same under both conditions,

$$0\,5 : 1 :: 12 : h$$

$$h=\frac{12}{.05}=24\text{ft.}$$

Another way of attaining the same result has been achieved by "Pelmar."

K at present = 1 mf.,
and is to be made = .5 mf.

$$\text{Now} \qquad K=\frac{l\,d\,s}{4h}$$

$$\therefore \quad \frac{K}{2}=\frac{\dfrac{l\,d\,s}{4h}}{2}$$

$$=\frac{l\,d\,s}{2\,(4h)}$$

Thus the height should be increased to twice the present height to reduce the capacity to half.

Question III.—When three condensers are joined in parallel, the total capacity is the sum of the three

$$=2+5+10=17\text{mf.}$$

When joined in series, the joint capacity is the reciprocal of the sum of the reciprocals of the three capacities, or

$$=\frac{1}{\frac{1}{2}+\frac{1}{5}+\frac{1}{10}}$$

$$=\frac{10}{8}=1.25\text{mf.}$$

Two condensers in cascade have a capacity of 10mf. One alone has 20mf. What is the capacity of the other?

$$\text{Total} \quad K=\frac{K_1\,K_2}{K_1+K_2}$$

$$\therefore \quad K_2=\frac{K_1\,K}{K_1-K}$$

$$=\frac{20\times 10}{20-10}=20\text{mf.}$$

Question IV. has been answered from formula as below :

K_1 = capacity of gp. cable.
K_2 = capacity of paper cable.

$$\text{Then} \qquad \frac{K_1}{K_2}=\frac{l_1\,s_1\,\log.\ 1.1}{l_2\,s_2\,\log.\ 2}$$

$$\frac{K_1}{K_2}=\frac{4\times\ \cdot\ .04139}{.30103}$$

$$\therefore \quad K_2=\frac{150\times .30103}{4\times .04139}$$

$$=273\text{mf. nearly.}$$

Another student obtains practically the same result in this other way.

The length being constant, the capacity of each cable will be directly proportional to the dielectric capacity of the respective insulators, and inversely proportional to the ratio of the logs. of the diameters.

$$\text{Log.}\ \frac{100}{50}=0.3$$

$$\text{Log.}\ \frac{55}{50}=0.04$$

For gp. S = 4
For paper S = 1

The two cables vary directly in capacity as 1 : 4, and inversely as 0.1333 : 1 respectively. That is, the gp. cable's capacity is to that of the paper insulated cable as $\frac{4}{1} : \frac{1}{0.1333}$

Substituting paper for gp. and diameters as per question—

$$x=\frac{\dfrac{150}{0\,04}}{\dfrac{4}{0.3}}=281.25\text{mf.}$$

Answer 131.25mf. *increase.*

The second half of this question has not been so completely answered as the others. "Electrification," says one student, "is the effect produced on an insulated conductor by raising the potential, either by contact with an electrified body or by joining it to a pole of a galvanic battery, when it assumes the same potential as the battery, and causes a straining of the dielectric surrounding it, thereby inducing an equal charge of the opposite sign on the surface which limits the dielectric. Practically it is the *charging* of a condenser such as is formed by an electric cable."

Another gives a somewhat different definition as follows :—"Electrification—supposing all bodies in Nature to consist of a large number of very small and distinct particles, which, when unelectrified, are quiescent or neutral, but in an electrified state are polarised—is the quantity of electricity an insulator will absorb and the time taken before these particles give up their neutrality. Until the latter is accomplished no thorough degree of insulation is assured, neither can the current reach its maximum at the distant end until the absorptive property of the insulator has been satisfied.

Moreover, the insulator takes the same time to discharge as it does to come under the influence of the current, which is termed the residual charge."

As a matter of fact, the latter is a better definition than the former, but neither of them is complete enough in itself. When a body is charged electrostatically it is said to be electrified, or influenced by static electricity. But the term "electrification" has another signification. It is a phenomenon observed when charging cables or condensers, and appears as if some of the electricity became absorbed in the insulating material. Some authorities view it as if it were due to the polarisation of the dielectric. Its retarding effect in electrostatics is somewhat similar to that due to hysteresis in magnetism, and is now becoming better understood than formerly. The word electrification is being applied very widely, but erroneously, by the daily Press to express the conversion of steam to electricity as the motive power on railways, &c.

Question V. has been neatly answered by "Pelmar."

"When the end of the wire is insulated the whole of the wire is at the same potential as the pole of an earthed battery applied to it, and therefore its effect on the particles composing the insulating medium surrounding it is the same throughout the length of the wire; but when the distant end is earthed, that end is at earth or zero potential, and there is a gradual fall of potential along the wire, therefore a corresponding fall in its inductive power on the dielectric."

"The quantity of electricity in a condenser," says another enthusiastic competitor, "is directly proportional to its capacity and the P.D. between the plates. An insulated line when charged has no P.D. between the battery and the distant end; but with a line earthed the P.D. gradually increases until $V - v = V$, so that the earthed end must, as regards voltage, = zero. If the mean voltage be taken in each case between identical points, we shall be able to determine the average quantity of electricity contained in the conductor between those points when the distant end is insulated or earthed. Let the distance in both instances between the two points be the total length of the line.

$\therefore$ Insulated P.D. $= V - V = 0$

$\therefore$ Battery end $= V$

$\therefore$ Distant end $= V \quad = 2V$ (1)

$\therefore$ Earthed P.D. $= V - v = V$

$\therefore$ Battery end $= V$

$\therefore$ Distant end $= O = \quad V$ (2)

$\therefore$ (1) Mean P.D. $= \frac{2V}{2} = V$

$\therefore$ (2) Mean P.D. earthed $= \frac{V}{2} = \frac{1}{2}V$

$\therefore$ Q insulated $= KV$

$\therefore$ Q earthed $= \frac{1}{2}KV$"

The second half of this question was intended more for comparative purposes than for actual results.

K_1 = overhead wire.

K_2 = underground wire.

s = dielectic capacity of insulation of underground wire.

$$\therefore \quad \frac{K_1}{K_2} = \frac{\dfrac{50}{4 \times 25}}{\dfrac{s}{\log. \frac{12}{5}}}$$

$$\therefore \quad \frac{K_1}{K_2} = \frac{\log. 2.4}{2s}$$

The above fulfils all that is required, but the following gives fuller details, and is sufficiently accurate to dispel any doubts the student may have as to the low value of the overhead line.

The length being the same in each case, it can be neglected.

$$\text{Aërial } K = \frac{k\,l}{\log. \frac{4h}{d}}$$

The mean value of k in this country = .0616 according to Kempe.

$$\therefore \quad K = \frac{.0616}{4.38} = .014\text{mf.}$$

$$\text{Gp. cable} = \frac{4 \times .0616}{\log. \frac{120}{50}} = .648\text{mf.}$$

$$\text{Paper cable} = \frac{1 \times .0616}{\log \frac{120}{50}} = .162\text{mf.}$$

If gp. as 1 : 46 } approx.,
If paper as 1 : 11.5 }

paper having about a quarter the dielectric capacity of gutta-percha.

A nearer approximation would have been obtained for the overhead value from the simpler formula

$$K = \frac{k\,l\,d}{4h}$$

The first part of the final question has been correctly solved by the majority of students as follows:

$$W = \frac{k\,h\,(b^2 - a^2)\,d^2}{D^2}$$

$$\therefore \quad W = \frac{25 \times 6\,(16 - 1)\,20 \times 20}{30 \times 30}$$

$= 10$lbs.

$k = .25$

$h = 6$in.

$b = 4$in.

$a = 1$in.

$d = 20$ mils.

$D = 30$ mils.

But the second half has been found a little more difficult, and has been omitted altogether by some.

"Treyar" answers the problems this way:

$$R=\frac{.00000085 \times 6\,[4^2-1^2]}{0.03^2 \times 0.02^2}=212.5.$$

Answer 212.5 ohms.

$$N=\frac{6\,[2-0.5]}{0.02^2}=22{,}500$$

Answer 22,500 convolutions.

In the June instalment there was an error in the working of the question on increase of resistance due to increase of temperature.

"Treyar" was right in his working out of the problem, and also in his reasoning. The temperature coefficient for copper is 0.00388 per ohm per degree C., a percentage increase of 0.38 per degree C., or 0.215 per cent. for each degree F. From formula

$$Rt = R\,(1+kt)$$
$$=476.6\,(1+.00388 \times 20)$$
$$=513.5 \text{ ohms.}$$

Increase $513.5-476.6=37$ ohms nearly.

It is very gratifying to know that the correspondence class has given so much pleasure to "Treyar." His kind letter and picture postcard were duly appreciated and will be referred to again.

The next set of questions bear upon construction. The chapters on that subject in Preece and Sievewright's "Telegraphy" are the best in that text-book. Students are recommended to read them.

EXERCISE VI.—JULY, 1905.

I. (*a*) Differentiate between a strut and a stay.

(*b*) What considerations would guide you in the choice of either?

II. Describe (*a*) how a strut and (*b*) a stay ought to be fitted to a pole.

III. (*a*) How are poles protected from lightning?

(*b*) What effect has an earth wire on a pole, on the insulation and the electrostatic capacity of a line?

IV. (*a*) What kind of timber is usually selected for poles?

(*b*) State the chief objections to iron poles.

V. (*a*) Discuss the merits and demerits of wood, ebonite, glass, earthenware, gutta-percha, paraffin, and porcelain for insulators.

(*b*) How is iron wire protected from chemical attack?

VI. (*a*) Find the relative diameters of two wires of equal length and resistance, the one being copper and the other iron.

(*b*) How is the height of poles regulated on roads, railways, and crossings?

(The next set of exercises will appear in the September issue, but students are requested to send July answers with as little delay as possible.)

CÆSAR AT THE TELEPHONE.

Flushed with victory, Col. Julius Cæsar left the scene of the battle and hurried to the nearest telephone booth.

"Hello, central," he said, "Give me Rome."

"A little louder, please," said central.

"Give me *Rome*."

"Stand closer to the telephone, put your lips against the receiver, and speak in a firm tone," ordered central.

"Think I am going to climb into this thing?" asked Cæsar. "You connect me with Rome or there'll be another magazine article provided for around here with you as the central illustration."

"Here's your party," was the only reply.

"Hello!" yelled Cæsar. "Is this Rome?"

"Yes."

"Gimme the palace."

The connection was made.

"Hello! Is this the palace?"

"Who is speaking?"

"Why, this is Cæsar."

"Sneezer?"

"No! Cæsar."

"Geezer? Who in the we—"

"Cæsar! C-Æ-S-A-R! Dadgum you! Can't you hear thunder? Julius Cæsar! Me! It! The whole thing! Got it now? Understand who's yelping at you?"

"Yes, sire."

"We've just won a great battle—"

"Great rattle?"

"No! Confound your muckle-headed ears! B-a-t-t-l-e! Get that?"

"Oh, battle. Thought you said—"

"Never mind what you thought. I'm doing the thinking for this community just now. We've just won a great battle, and I want you to put a bulletin on the walls of the city where everybody can see it."

"Yes, sire."

"Better write it down now, so you'll get it right. Listen, now. Are you ready?"

"Yes, sire."

"Well, say, 'Veni, vidi, vici.'"

"Yes, sire; I have it. Beany, bidy, bicy."

"No, no! Veni, vidi, vici!"

"Sheeny, shidy—"

"Great heavens! Were you never at school? Veni, vidi, vici."

"Oh, weeney, widy, wicy. I'll go and tell Mrs. Culphurnia—"

"Here! Wait! You haven't got it at all! I said, Veni, vidi—"

"I have it now. Clean eye, cried I—"

"Now, by the shade of Mars, this is too much! Out upon thee, dog! Would that my fist could reach thee, even as my voice doth! Back to the woods!"

"Tell it me once again, and I—"

"I'll tell you to—"

Here central broke in, saying:

"Did you get your party?"

Then did the royal rage of the late J. Cæsar manifest itself, and the telephone building was scattered over the plain, while the central girls fled shrieking for home and mother.

And thus it was that the loyal populace of Rome must needs wait until the slow feet of a messenger brought them tidings of the glorious victory.—*Chicago Tribune.*

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

Electro-Chemistry in Germany.

The Annual Meeting of the Bunsen Gesellschaft at Karlsruhe.

By JOHN B. C. KERSHAW, F.I.C.

THE Bunsen Gesellschaft of Germany is the oldest of the societies for the study of electro-chemistry, having been founded in 1894, while the sister societies in the United States and in the United Kingdom are of much more recent date. Three years ago the name of this society was changed from that of the "Deutsche Elektrochemische Gesellschaft" to the somewhat unwieldy title of the "Deutsche Bunsen Gesellschaft für Angewandte physikalische Chemie," and since that year it has been devoting itself to the study of problems lying on the borderland between physics and chemistry, and less to purely electrolytic or electro-metallurgical phenomena.

During the eleven years of its existence, the society has, however, done much to promote the study and knowledge of electro-chemistry in Germany. Many of the more important laboratory investigations relating to the theory of the electrolysis of salt solutions have been carried out by its members, and the results of these have been published in past issues of the official organ of the society —the *Zeitschrift für Elektrochemie.* The present membership of the society is about 900, and is somewhat cosmopolitan in character. At the meeting held in Bonn last year, two English scientists were specially honoured—Sir Henry Roscoe and Professor Ramsay being added to the small group of honorary members of the society. The eleventh annual meeting of this important society was held at Karlsruhe, near Wiesbaden, on June 2nd and 3rd last, and no less than thirty-one papers were read and discussed during the two days of the meeting. In the following pages short abstracts of some of the more important of these papers are given, and an appendix is added, containing a full list of the papers and authors at this gathering. (This will be found in "World's Electrical Literature.") The meeting was favoured by fair weather and a large attendance, and the presence of Professors Ostwald, van't Hoff, Nernst, and Le Blanc added importance to the discussions.

Professor Elbs (Giessen).—Accumulator Cells Without Lead.

The author dealt with the principle of all non-lead accumulator cells, and pointed out that one essential difference between the two types was, that in the lead accumulator cell the electrolyte took part in the chemical reactions of the cell, while in the non-lead accumulator cell it simply acted as an electrical conducting medium.

The chemical reaction in the usual alkaline accumulator cell was: $Fe + 2Ni(OH)_3 = Fe(OH)_2 + 2Ni(OH)_2$.

Iron has a tendency, however, to assume the passive state in concentrated solutions of alkali hydrate. This tendency can be checked by heating iron in the state of filings in the air, reducing the oxide in hydrogen, and by submitting the reduced iron to cathodic action in a KOH cell. The iron treated in this way depolarises fairly quickly when used as anode in an alkali cell, but it suffers from the defect that the chemical and physical changes have only affected the surface of the iron filings, and a core of unaltered iron remains. As regards the successive steps in the oxidation of this iron, nothing very certain is known.

It is probable that the hydrate formed is that of the divalent iron $Fe(OH)_2$, and that the easily recognised yellowish trivalent hydroxide $Fe_2(OH)_6$ forms only by later oxidation due to the air. This trivalent hydroxide is, however, not easily reduced to the lower stage of oxidation by cathodic reduction. The reactions at the iron electrode are therefore:

$$1 \quad Fe \rightleftarrows Fe(OH)_2 \text{ (chemical)},$$

$$2 \text{ and } Fe \rightleftarrows Fe^{\cdot\cdot} + 2 \ominus \text{ (electrical)}.$$

The oxidation product of $Ni(OH)_2$ is always $Ni(OH)_3$, and never a higher oxide; while the reduction product of the latter is always $Ni(OH)_2$.

The reactions at the nickel electrode are therefore:

$$1 \quad Ni(OH)_3 \rightleftarrows Ni(OH)_2 \text{ (chemical)},$$

$$2 \text{ and } Ni^{\cdot\cdot\cdot} \rightleftarrows Ni^{\cdot\cdot} + \oplus \text{ (electrical)}.$$

The capacity of the cell does not increase with use, since the iron electrode cannot be further *formed* by continual charge and discharge. The solubility of nickel hydroxide in caustic potash solution is very small, as compared with that of the cobalt hydroxide; the latter is not therefore adapted for use as a substitute for nickel in an accumulator cell. The E.M.F. of the freshly charged cell varies from 1.42 to 1.48 volts. This falls slowly on standing, or by discharge quickly, to 1.35 or 1.37 volts, so that 1.36 volts must be regarded as the normal E.M.F. of the cell. This E.M.F. is independent of the concentration of the electrolyte.

Dr. Werner von Bolton.—Tantalum and the Tantalum Lamp.

The author dealt with the history of this rare metal and described the method by which he had prepared the first rods of tantalum for use in the new electric lamp of Siemens and Halske. Tantalum tetroxide was first made by heating the pentoxide with carbon to a white heat, after rendering it plastic with paraffin.

The rods of tetroxide were then provided with platinum contact pieces at each end, and after fixing in an exhausted glass bulb were submitted to the action of an alternating current. The metal separated at the cathode and the oxygen at the anode. This oxygen did not attack the metal, owing to its highly rarefied state. As a white heat was approached, white metallic patches appeared upon the rod, and gradually increased in size. The metal obtained in this way could be bent on raising to a moderate temperature. The above method of preparation had, however, been discarded in favour of one in which a mixed salt of tantalum fluoride and potassium fluoride was reduced by potassium. Pure metallic tantalum was obtained by this method, mixed with its oxide. The separation of the tantalum and the unaltered oxide was finally effected by fractional distillation. The author showed a regulus of the metal weighing 64 grammes, which had been obtained by this method with an expenditure of 75h.p. Details of the method were, however, not forthcoming. The metal was very ductile, and wire only .03mm. in diameter could be manufactured by drawing down. It could also be bored or cut with hardened steel, in quicksilver; but the steel cutting tools quickly lost their edge. If the metal contained unaltered oxide, its hardness was greatly increased, and it was then harder than the diamond. Since such an oxide-holding metal is tougher than the best hardened steel, it would form an almost perfect protective metal for battleships and cruisers; but the cost renders this application of the metal out of the question.

The minerals containing tantalum are, however, fairly widely distributed, and it is the cost of extraction which renders the metal so expensive. Tantalum is of interest to the electro-chemist by reason of its assumption of the passive state under certain conditions. A cell composed of two electrodes of this metal, with sulphuric acid as electrolyte, will not allow an alternating current of even 120 volts to pass. By substituting platinum for tantalum as one electrode, the cell allows current to pass in one direction only, and such a cell can therefore be used as a current rectifier. Tantalum at a red heat decomposes water, and burns with evolution of hydrogen. A fine wire of the metal ignited by a match burns slowly in the air, with formation of the pentoxide. As the melting point of the metal lies in the neighbourhood of 2,300°C., tantalum volatilises little when used in glow lamps, and it is therefore specially suited for this purpose. The light produced for a given energy consumption is also much higher than with carbon. The author exhibited a tantalum lamp, in which 65cm. of fine tantalum wire was fixed upon a central support, of glass rod and nickel arms, having the shape and appearance of an

umbrella-frame. The tantalum wire was stretched round this frame, upon the nickel arms extending from the central glass rod. A lamp taking 1.5 watts per candle had a temperature of 1,700°C. or 600°C. lower than the melting point. At temperatures above 1,700°C. the metal becomes crystalline in structure. A 25 candle-power tantalum lamp requires .35amp. at 110volts, or 1.55 watts per candle, whereas the ordinary carbon filament lamp of the same power requires twice this current. The energy consumption of the new lamp is therefore about equal to that of the small Nernst lamp. If the tantalum wire of the new lamp be heated above 2,000° C., the light becomes unbearable to the naked eye: and with an energy consumption of 3.00 watts per candle, at which the lamp has a power of 330 candles, the metal melts.

(*To be concluded.*)

(*M. J. Garcin's N-Ray Article is held over until next month.*)

The Borchers Furnace.

By F. A. J. FITZGERALD.

In the year 1849, Despretz presented to the Académie des Sciences, in Paris, certain papers that have considerable interest in connection with electric furnace work, and are by no means as well known as they ought to be. Despretz described how he had fused and volatilized various refractory substances, such as magnesia, silicon, boron, platinum, &c. Finally he read papers specially devoted to certain experiments, which, in his opinion, clearly demonstrated the fusion and volatilization of carbon. Moissan has since shown* that carbon is infusible at ordinary pressures, even when raised to the highest attainable temperature; but that does not lessen the interest in Despretz's paper, which contains much that is important.

The body of the furnace used by Despretz was made of cast iron, and had a movable cover. The latter carried a leather stuffing box, through which a rod passed vertically, the rod being insulated by two glass plates and two small leather washers. At the end of the rod was a carbon terminal, the other carbon terminal being connected to another rod passing through a suitable tube in the side of the apparatus. The interior of the furnace body could be observed through two large tubes closed with thick plates of glass. A fifth tube could be connected either to a vacuum or compression pump, while another tube permitted connection with a manometer.

With this apparatus Despretz was able to make experiments, using either carbon resisters or arcs. When he wished to develop heat by means of a resister he connected the carbon terminals carried by the vertical and horizontal rods with a small rod of carbon, through which the current was passed. When an arc was required the furnace was fitted with a different cover, so arranged that by means of a third rod the substance under examination could be introduced into the arc formed between two carbon rods.

The apparatus described above had a capacity of ten litres, and was only used in experiments where it was desired to work under increased pressure. In experiments under atmospheric pressure the electric furnace was covered with a large bell-jar.

An illustration of the Borchers furnace is given in Fig. 1. T1 and T2 are heavy carbon terminals which are connected electrically by the resister, R. The connections between

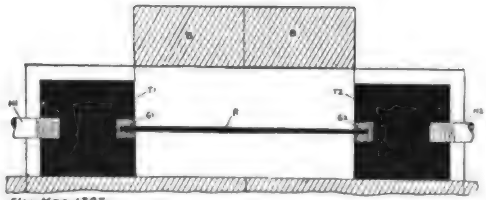


Fig. 1. Section Through Borchers Furnace.

the resister and the terminals may be made by drilling holes in the terminals and packing with graphite, G1 and G2, as shown in the figure. The connections to the source of current are made at H1 and H2. The material to be heated surrounds the resister, R, and the furnace is covered by the bricks, B. According to Borchers, all oxides may be reduced in this furnace.

The data given by Borchers for this furnace are as follows:

"An electromotive force of 0.3 to 0.4 volt is necessary to drive a current of 1 ampere through 1mm. of a carbon pencil at the temperatures of these experiments, with a current density of 6 to 10 amperes per sq. mm. of sectional area."

This would give a resistivity of 0.005 to 0.004 ohm, which is somewhat higher than required in the case of graphite rods. It should also be observed that a current

* "Le Four Electrique," Paris, 1877, p. 160 et seq.

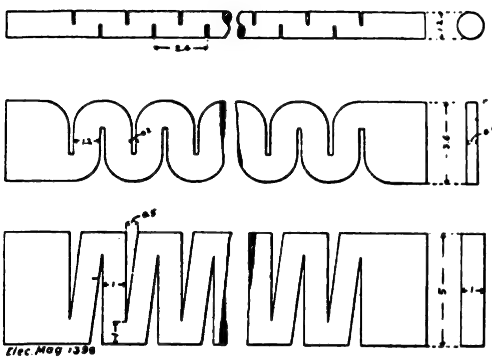


Fig. 2. Special Forms of Resisters.

density of 6 to 10 amperes per sq. mm. of sectional area in carbons having the resistivity of those mentioned would give an enormously high temperature unless the diameter of the carbon were very small.

In designing a Borchers furnace the general principles that have been considered in dealing theoretically with the resistance furnace must be kept in mind. It is not necessary to make very close calculations of dimensions because of the unknown factors which enter into the actual working of the furnace; but time is saved and results more quickly obtained by making approximations to the theoretical conditions.

A furnace was actually built at the FitzGerald and Bennie Laboratories for certain experiments. The furnace was constructed originally for the purpose of studying the behaviour of this particular type, and was used for making a silica tube. After it was built it was filled with pure quartz sand, which completely surrounded R. Two runs were made on consecutive days, the furnace thus having plenty of time to cool between the first and second runs. After the furnace had cooled, following the second run, the resister was removed from the furnace and was found to be surrounded with a fused quartz tube. The maximum exterior diameter of the quartz tube was 6cms., and its length 52cms. It weighed 1.54 kilogrammes.

The temperature to which the tube was heated must have been very high, for taking the inside diameter of the tube it is found that with the maximum kilowatts of 5.9, there were 1.8 kilowatts per square decimetre of the inside surface of the tube. This must have produced a very high temperature in the interior of the tube, and judging by its appearance the silica must have been raised to its boiling point. Through an accidental occurrence an approximation to the temperature of the tube was obtained. Some small pieces of coke dropped into the sand used in the experiment, and one piece was found in a small cavity, near the outer surface of the quartz cylinder, about 2.5cms. from its axis. Here, when the maximum kilowatts were developed, there were only 690 watts per square decimetre, yet the grain of coke was covered with crystals of silicon carbide.

It will be readily seen that a serious objection to a furnace built with a solid resister as just described is the low resistance of the solid carbon resister, which involves the use of heavy currents of low voltage if large amounts of power are required. A closer approach to a practicable resister might be made by using one having a rectangular cross-section, for this shape would give a greater heating surface for the electrical resistance of a given length.

Some examples of improved forms of resisters are shown in Fig. 2. These may easily be made from graphitized articles with the help of a hack-saw. The forms shown in the figure have been made and used in the laboratory for various purposes, and were found to give satisfactory results. It should be noted here that in connecting the resisters having a rectangular cross-section to the terminals a good method is to cut slots in the latter, the dimensions of the slots being greater than those of the section of the resister. The ends of the resister are then put in the slots, and empty spaces tightly packed with graphite. In using resisters of the kind described above, it may be objectionable to have the furnace charge get into the spaces between the sections of the resister. In that case the spaces may be filled with agglomerated charcoal powder, which is a non-conductor compared with the resister material. Before using the charcoal for this purpose it should be ignited at a very high temperature to remove all shrinkage. A satisfactory agglomerating material is a strong solution of sugar. It is a good plan to use charcoal in any case where, for example, the resister is like the lowest one shown in Fig. 2. Unless this resister is handled carefully, it is likely to break, but if the V-shaped spaces are filled with the agglomerated charcoal it makes a pretty strong article. — *Electrochemical Industry*.

This is a new section which will deal with an important branch of electrical industry. Every aspect of the design and manufacture of electrical apparatus will be dealt with month by month, and Engineers are cordially invited to contribute.

THE DESIGN OF INDUCTION MOTORS.

(Specially contributed.)

By H. M. HOBART.

THE writer has so recently contributed articles relating to the design of induction motors* that it might appear unwarranted on his part to again revert to the subject. He has, however, found it useful for his own purposes to correlate various features of these articles into a single consistent plan of design, and at the same time to incorporate some modifications based upon subsequent developments along these lines. It is the object of the present article to set forth the result of this work.

The first step in proceeding to design induction motors should relate to investigating the values for the "output coefficient," which experience has shown to be practicable. The "output coefficient" is denoted by "ϕ," and has been defined as follows by Esson and Kapp:

$$\phi = \frac{W}{D^2 \times \lambda g \times R}$$

where

W = Rated output in watts;

D = Diameter at the air gap in centimetres, *i.e.*, the rotor diameter;

λg = Gross core length in centimetres;

R = Rated speed in revolutions per minute in the working out of designs.

During recent years, rapid advances have been made in reducing the cost of production of induction motors. This has been accomplished, first by higher values of the "output coefficient" which a better understanding of the methods of designing have permitted, and second, by greater attention to the mechanical design in the matter of reduced weight of material, the choice of material of minimum cost, and attention to the design in general from the standpoint of a reduction in labour. Manufacture in quantity and the employment of standard parts for motors of different capacities have also contributed to the same end. In a paper recently read before the German Institution of Electrical Engineers,* the rate of decrease in the cost of three phase motors of from 1 to 50h.p. capacity, during the last five years, is shown by Table I.:—

TABLE I.

——	1900	1901	1902	1903	1904
Selling price..	100	85.2	74.0	69.4	64.0
Material ..	100	81.8	74.5	69.0	64.3
Wages	100	83.8	67.9	58.0	53.5

* *Traction and Transmission*, Vol. viii., p. 46, Sept., 1903; "Die Wahl des Rotordurchmessers bei Induktionsmotoren," *Elektrotechn. Zeitschr.*, Heft xlvi., p. 933, Nov. 12th, 1903; *Proc. Inst. Elec. Engrs.*, Vol. xxxiii., p. 284, 1904 (contribution to the discussion on Dr. Behn Eschenburg's paper entitled "On the Magnetic Dispersion in Induction Motors and its Influence on the Design of these Machines"); "The Rated Speed of Electric Motors as affecting the type to be employed," *Proc. Inst. Elec. Engrs.*, Vol. xxxiii, p. 472, 1904; "The Choice of the Air Gap Diameter for Induction Motors," *Electrical World*, Vol. xliii., Jan. 23rd, 1904; "Die Vorausberechnung von $\propto$ für Drehstrommotoren," *Elektrotechn. Zeitschr.*, Heft xvii., p. 340, April 28th, 1904; "The Design of Induction Motors and Examples from Recent European Practice," *Electrical World*, Vol. xliii., p. 805, April 30th, 1904; "Einfache Berechnung von Drehstrommotoren," *Zeitschr. für Elektrotechnik*, Vienna, Vol. xxi., Heft xi., p. 153, March 13th, 1904; "Electric Motors, London, Whittaker and Co., 1904; "A Method of Designing Induction Motors" (paper read before the International Electrical Congress, Section G., St. Louis, 1904): "Motoren für Gleich und Drehstrom," Berlin, Julius Springer, 1905.

* "Preisbewegungen und Lohnfragen mit besonderer Berücksichtigung des Pramien-Lohn-Systems," R. Gundel, *Elektrotechn. Zeitschr.*, Heft vii., p. 176, Feb. 16th, 1905.

From Table I. it is evident that the selling price is to-day about two-thirds of the price in 1900. It is claimed by the German manufacturers that they have solved the problem of meeting these reduced prices with a suitable margin of profit and without reduction in the earnings of their workmen, and that a large factor in obtaining this result relates to organisation of production.

The present article, however, concerns itself with the component of the savings consequent upon improvements in designing methods, and in this connection Table II., also taken from the paper above referred to, is of great interest. It aims to show the chief changes in design which have occurred since 1897, and relates to 50 cycle three-phase induction motors rated at 1h.p. at 1,500 revolutions per minute.

TABLE II.

——		1897	1899	1902	1903
Magnetic Density	In air gap	3380	4040	5860	5860
	In armature core	4000	5400	7170	7170
	In teeth	7000	13000	18700	18700
Current density in amperes per square centimetre		300	350	525	525
Ampere conductors per centimetre of periphery		67	95	150	150
Kilo-grammes weight of effective material	Copper	5.5	6.5	8.4	8.4
	Iron	62	30	13	13
	Total	125	90	50	44
Type of bearings		With oil rings			Ball bearings

Although the "output coefficient" is not given in Table II., it is, nevertheless, very evident from the greatly increased densities in copper and iron that the output coefficient of the 1903 motor of the Table is out of all proportion higher than the output coefficient of the 1897 motor. In fact, if we assume that in the 1903 motor the total area of the surface of the teeth at the air gap bears the same relation to the gross area of the air gap as in 1897, the increase in the output coefficient may evidently be obtained from the ratio of the products of the magnetic density in the air gap and the ampere conductors per centimetre of periphery. This ratio is equal to—

$$\frac{5{,}860 \times 150}{3{,}380 \times 67} = 3{\cdot}9$$

i.e., the output coefficient of the 1903 motor is almost four times as great as that of the 1897 motor.

(*To be continued.*)

Materials for High-Tension Insulators.

THE subject of materials for high voltage insulators will be of greater interest to electric power engineers in this country, by reason of the removal of restrictions on overhead bare conductors. We have still much to learn in this field of work, and advice tendered from the chemist's side of the argument should be welcome, as, after all, the solution of a difficult problem rests in the main in his hands. We append a letter addressed to the editors of the *Electrical World and Engineer* which should prove of great value.

"As a chemical and ceramic engineer I see these matters from an entirely different point than the electrical engineer, and can possibly throw some light upon disputed points. The average green or white glass in use to-day has a composition of about one unit flux and two and one-half units silica, which means that it would be classed as a low silicate. All low silicates are more or less apt to deteriorate in time by exposure, some even crystallising on exposed surfaces. This breaking up of the surface structure creates a resting place for an accumulation of dirt, and hence the tendency to 'spill over,' as you state.

"If glazes used on porcelain are of as low silicate composition as are the glasses, they also are subject to the same tendency to deteriorate and become rough by long exposure. This is especially true if any lead is used in the compositicn, since lead silicates are most easily attacked. Hence for insulators a glaze must be used the composition of which is such that the atmosphere has nothing to attack. The idea prevails that the very smooth, glass-like glaze is the most desirable surface covering, but as we are confronted by the fact that to obtain a glass-like surface the glaze must

flow, the glaze must be either a very low silicate or contain lead.

"We can see at a glance that the electrical engineers are asking for something which in reality they do not want. Furthermore, this glazed surface, due to flowing, has a tendency towards crazing or cracking. What the engineer really wants is a glazed surface to which dust will not attach itself any more than to glass, but without the glass composition and its accompanying deteriorating tendency; and this is exactly what my company — the Locke Insular Company—is prepared to give them. The point which I particularly desire to mention is the fact that porcelain never should depend upon its glaze for puncture strength, nor do any of the porcelains which this company is using to-day. Porcelain can be and is made, right here in our factory, which will stand higher tests unglazed than any glass that we have been able to obtain, either imported or domestic. I do not claim that the glaze has no insulating value, but, in order to ensure a perfect insulator, the glaze should never be depended upon, since there must be portions of the insulators which are, of necessity, left unglazed, and these would be weak points in any vitrified porcelain.

"That large pieces of porcelain cannot be successfully vitrified is also erroneous. True, they cannot be properly fired at the same time as smaller or light ware, but we can and do fire very heavy blocks of porcelain, and guarantee them to be thoroughly vitrified. The real fault with heavy pieces of porcelain rests in the fact that some interior flaws may exist which the volume of the piece prevents the workman from detecting and correcting. A thin piece of porcelain can be produced with much less danger of flaws, and when present they are apparent, and the piece can be condemned.

"The fact that insulating porcelain is as a rule not so white nor so well glazed as fine table ware is due to the fact that mechanical strength being a factor with insulators, it is very essential that the material be of as fine grain and texture as possible, and this is impossible where only the china clays of the common white ware are used. Furthermore, should electrical porcelain be so compounded that a glassy fracture is obtained, you would have the same inherent weakness or brittleness that you find in your imported china, and which is only more apparent in glass. If porcelain is properly combined and properly fired, a test will determine whether it is faulty or not. If it is perfect, I believe it will stand the potential for which it is built for 1 or 1,000 hours. This opinion is reached after an experience covering several years. I have never seen a perfect piece of porcelain that showed any evidence of deterioration from exposure or use. In every case the insulator has been faulty in composition or imperfectly fired. The same is the case with the glaze.

"With glass you say a flaw can be detected. Why, then, do glass insulators so often break completely in two after months or even years of use, a thing never known with porcelain? It is because a flaw existed which could not be detected and which developed by exposure until too weak to stand the strain placed upon it."

Measuring the Slip of Induction Motors.

By F. LAWTON STONE.

The accurate measurement of the difference between any two large quantities, experimentally obtained, has always been a very difficult task. If it is attempted by the method of observing both of the large quantities and then subtracting the one from the other, the result is always open to question. Suppose the one value is 900 and is read one-half of 1 per cent. low, and the other value is 910, and is read one-half of 1 per cent. high, so that the former appears to be 895.5 and the latter appears to be 914.5. By subtraction the difference seems to be 19.00, when, as a matter of fact, had everything been read with absolute accuracy, a difference of only ten would have been found. The error in the result is 90 per cent. It is, of course, absurd to think that in commercial testing results can be obtained with an error less than one-half of 1 per cent. The experimental determination of the slip of an induction motor depends upon the accurate measurement of the difference between two large quantities, *i.e.*, the synchronous speed and the actual speed, and an error of 1 per cent. in the reading of these quantities may make an error of 100 per cent. in the result.

To overcome this difficulty several ingenious methods have been devised. The simplest of these is, perhaps, the disc and arc lamp method, which, in a word, consists in attaching to the shaft of the induction motor a

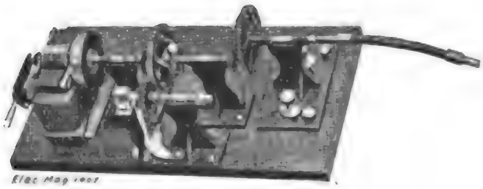


FIG. 1. COMPLETE MEASURING DEVICE.

disc with as many black and as many white sectors as the motor has poles. When the disc is viewed in the light of the arc lamp, the sectors will be seen to revolve slowly backward at a rate equal to the slip.

If the slip is not over 40 per minute, it may be counted by following one sector with the eye. If the slip, however, is over 40 it becomes very difficult to follow, and the results are accordingly uncertain. Also, the light from the incandescent carbon is often so great that the difference between the maximum and minimum light is not enough to allow one to distinguish the sectors. Furthermore, a very large " personal equation " of the man counting the slip has to be considered, so that altogether this method is not highly satisfactory.

Realising the uncertainty of the above method and the importance of accurate slip measurements, the author, about a year ago, made use of a piece of apparatus composed of a differential gear and synchronous motor, which has practically eliminated all trouble and is perfectly automatic, recording the slip on a counter.

A very clear idea of the device can be gained from Fig. 1. To the left is a small synchronous motor with a speed corresponding to a four-pole machine. There is a differential gear in the centre, and a nest of gears on a movable pedestal at the right. The gears in this nest are so proportioned that they correspond to the speed of a motor having from two to twelve poles. If the slip is to be taken on a 12-pole motor, the dowel pins and thumb screws in the base of the pedestal are removed, the large gear engaged with the pinion of the differential gear, the dowels replaced, and the thumb screws replaced. There are dowel holes corresponding to each gear, and the slot in the base allows the base to slide back and forth.

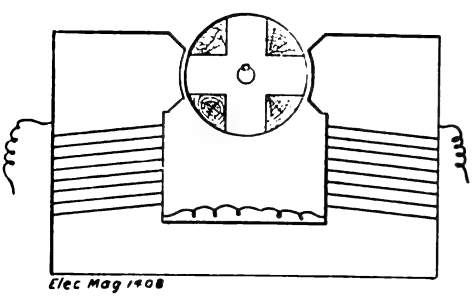


FIG. 2. SPECIAL DRIVING MOTOR.

The motor for this device is a four-pole single-phase synchronous machine of rather unique design. The revolving part, which in reality corresponds to the field and on the number of whose poles or projections depends the speed, is built up as shown in Fig. 2.

The cross-shaped pieces are made of laminated steel and keyed to the shaft, and the spaces between the projections are fitted with wooden blocks. The stationary part is built up of laminated steel. The operation of the motor is purely magnetic. The current reaches zero just as the rotor assumes the position shown in the sketch. The momentum of the revolving parts carries the rotor past this point, so that when the projections are advanced 45° the current and flux are maximum and exert a pull upon the projections. Such a motor is, of course, not self-starting. When it is necessary to make the motor self-starting there is attached to the shaft a contact device which breaks the current when the rotor is in the position shown in the sketch, and completes the circuit when the rotor advances a few degrees, and so on continuously for each 90°.

The direction of rotation depends alone on the direction in which the motor is started by hand. To start and synchronise the motor for the slip machine, it is only necessary to connect the flexible connection to the shaft of the induction motor and hold the differential gear stationary by hand. This will bring the motor up to the speed of the induction motor. The circuit to the synchronous motor may then be closed, and the motor will jump into synchronism at once. The differential gear will then revolve at a rate which is directly proportional to the slip.

If the poles on the induction motor are four (the same as on the synchronous motor) the differential gear will travel at a speed equal to exactly one-half the slip. To take care of this factor ($\frac{1}{2}$) the diameter of the counter gear is one-half that of the gear about the differential system. When taking observations of the slip the load on the motor is held constant, and the E.M.F. and speed of the alternator are as nearly constant as possible. The counter, before being engaged, is read and the reading recorded. Then, at a signal, or simultaneously with the starting of the stop watch, the button in the base of the machine is pressed down. This engages the speeder shaft with the small gear of the differential system. At the end of a specified time the button is released and the counter disengaged. The new reading on the counter is now recorded, and the difference between the two, divided by the number of revolutions of the synchronous motor, is the slip of the induction motor expressed with synchronism as unity.—*Electrical World and Engineer.*

The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

Continuous Current Networks, Metallic and Non-Metallic Sheathed Cables.

By L. R. LEE, Manchester.

(This article has been held over through lack of space. Mains Engineers and Cable Makers are invited to join in the discussion.)

A FEW months ago in the pages of this magazine appeared an article on the faults incidental to underground electric mains and the remedy for such. In view of the absorbing interest of this subject to electrical men in charge of electric cables, and with a thought for the recent heavy breakdown in Bradford, it may be of interest to review somewhat the article mentioned above and to carry the whole matter a little farther in discussion.

We will take the points of Mr. Cleary's article in the order in which they are placed by him; and we come to our first stop on page 651, where, after remarking that although a decade ago cable joints may have been the weak spots, still they are no longer so, he at once contradicts this statement by saying that 75 per cent. of the fault trouble is due to the present day iron joint-box. However, putting aside this contradiction, let us look at the question of the joint-box. In the first instance, everyone must admit that unless one has lead sheathed cables, lead wiped joint-boxes are not much use, and it would be interesting to know if Mr. Cleary thinks that in, say, five years' time any engineer will be using lead sheathed cables for continuous current networks. Personally, I feel convinced that the engineer of that date will not; and even now experience shows that engineers are becoming somewhat shy of such cables. Again, it cannot be accepted as fact that the iron joint-box is responsible for 75 per cent. of the faults occurring on electric mains. In my own case, after an experience extending over fifteen years, the last five years of which have been spent on a network containing 700 miles, approximately, of all classes of low tension cables, in addition to a large network of H. T. feeders and telephone cables—all of which cables are equipped, to the extent of several thousands, with the iron joint-box—I am able to state emphatically that I have never seen a fault which has occurred in such a box, if the box has been well designed and properly put together. In fact, I have only known, during these fifteen years, of four faults which have occurred in iron joint-boxes, the first and fourth of which were due to bad workmanship on the part of the jointer, and the second and third being due to faulty designs, which fault of design was known to me before the boxes were put away, and was commented on by me.

Fig. 1 shows an iron service-box now in use on the five wire Manchester mains—a similar but somewhat smaller box is used for the three wire mains—and this box, *without even end plates*, has certainly added years of life to the Manchester mains. The box is used on wood and iron troughs and with lead sheathed and vulcanised bitumen sheathed cables, which, by the way, are always charged. The box depends solely on the filling compound, which is always to be relied on if the jointers do their work properly. The box is put on after the

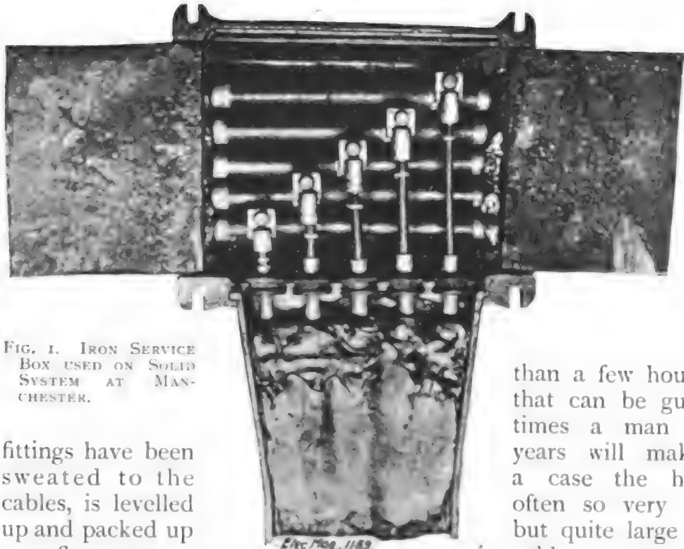


FIG. 1. IRON SERVICE BOX USED ON SOLID SYSTEM AT MANCHESTER.

fittings have been sweated to the cables, is levelled up and packed up on a flag stone so that it cannot be shifted, and earth is then rammed round it to prevent the compound running out, which compound is allowed to set hard before the jointer leaves his work or even closes down his box, to within, say, half an inch of being full; this half inch is put in last of all. After the compound has once set, it cannot run out unless the fittings become hot through bad contacts. There is more than one way of filling a joint-box with compound; the proper way is to fill from one corner only, and pouring right down to the bottom of the box, allowing the compound to rise round the fittings, so driving upwards all air, and the compound must be hot and liquid. In this matter of temperatures at which the compounds are liquid, it is as well for the engineer to test several samples for himself, using the one which becomes most liquid at the lower temperature, other things being satisfactory. No; it can safely be said that faults occurring in joint-boxes are not usually due to the boxes or the compounds, but to careless workmanship. I do not wish to say that the lead wiped joint-box may not have some very useful attributes and be all right in its place; but to believe that the lead box is the only box suitable, engineers would need to discard all cables but lead sheathed, thereby running themselves into much graver troubles, of which mention will be made later.

Before leaving page 651, I do not quite agree with Mr. Cleary that the mains engineer should have to worry himself with the design of joint-boxes, &c., although he often does so, because it seems to me high time that makers of such gear should employ persons capable of designing a good standard box; there is no reason why a joint-box should not be standardised as much as a cable.

On the question of plumbing, it takes more than a few hours' practice to make a joint that can be guaranteed watertight. Sometimes a man who has been at it for years will make a failure, and in such a case the hole left in the plumb is often so very small as to defy detection, but quite large enough to injure a dry core cable.

Passing on to part two; if true, it must be because of the necessity of cutting the outers and so adding resistance to the conductors that engineers are prejudiced against concentric cables; but even here the lead wipe box does not get over the difficulty, as the outers still have to be cut, and it is difficult to assign any other reason than the above for the prejudice against these cables. Here again it must not be forgotten that a lead box is only for use on a lead sheathed cable. With regard to the iron box furnished with screwed unions on to which the lead is wiped, such a box again brings the engineer face to face with other troubles, *viz.*, electrolysis, unless proper precautions are taken. Mr. Cleary is quite right in his remarks *re* sweating of connections; all must be sweated if good results are required. On page 193, part two, the method of working or jointing on a *live* cable is described, but even if the cable is alive, if it is only fed from one end, as many cables are, all consumers on the far side of the joint are temporarily cut off and this cannot be allowed in large towns. In making a concentric joint the bars should be put in place before the conductors are cut, or the conductors should be temporarily strapped across, each with a piece of small insulated cable; it is in such a case as this where one gets the chief advantage from the use of single conductors.

(To be continued.)

Central Station Advertising.

"THE Denver-Colorado Springs Convention of the National Electric Light Association will go down into history as the one marking a great awakening among central station men on the question of new business getting. It is well that so much emphasis was put on advertising, because it is on this particular point that many electric light men have been entirely too conservative or indifferent in the past decade. It is just as easy, and perhaps easier, to waste money on advertising as it is to waste it on mistakes in engineering and construction. But that does not detract from the value of well planned advertising, and it is now thoroughly established that electric light and power companies are as likely to find advertising profitable as any other concerns having *things* to sell."

Our esteemed contemporary, the *Electrical World and Engineer*, thus comments editorially on the dawn of a new era in electricity supply. Americans are generally keener business men than we are, and in this particular they have proved themselves no exception to the rule. Central station engineers in this country must wake up at once to the fact that unless they advertise, like others in commercial affairs, they will lose the business to those who avail themselves of publicity at every turn.

Mr. L. D. Mathes, of the Union Electric Co., Dubuque, U.S.A., thus expresses himself on the subject of obtaining business in electricity supply:

"To conduct successfully an advertising campaign for the sale of electricity or any other product, system and order are absolutely essential, and these are the first features which impress one in looking into the 'business getting' departments of the larger central stations. The soliciting force, whether it be two, ten, or one hundred men, has its work laid out and its daily task to perform. In Chicago, New York, and Boston the territory is cut up in districts, each solicitor having so many squares, or blocks, as his territory. Reports are made daily on the number of calls made, business secured or lost, and the general prospects.

"The mailing lists should be entered under separate headings—for instance, one list covering motors, another residential lighting, another window lighting, &c. The card-index system is readily adapted to this class of work, and has been generally adopted by all lighting companies. The advertising matter sent each customer should be noted on the index cards or mailing lists in order that duplicate matter may not be mailed the same individual. While system is essential we must guard ourselves against too much of it; if it requires all of the solicitor's time to keep up with the system, he does not make much headway in getting in direct touch with prospective customers.

"It is a well-defined fact that all printed and intelligently circulated matter will receive more attention in the smaller cities, the general public having more time to read and digest such matter. A well-written circular will bring a far greater percentage of acknowledgments in a town of 25,000 to 50,000 than in a city of 100,000 or greater population. Assuming that a customer has been secured and his name transferred to the ledger and meter-card index, it does not hold that he should be dropped from the mailing list, but rather, that having been induced to see the possibilities of electricity to the extent of taking on the service, the next matter forwarded him should be with the end in view of calling to his attention the various comforts and conveniences possible to the users of the electric service. "After all has been said, the method of securing additional light and power business narrows itself down to any method which appeals to us as being sound from a business standpoint and profitable from an income standpoint, whether there is an established precedent of the method or not."

No less than three papers read at the National Electric Light Convention dealt with central station advertising, and the discussion on these elicited some cogent remarks from various speakers. Mr. T. C. Martin summed up the situation very clearly, and his extensive and almost unique experience of advertising methods lends weight to the value of his arguments.

"He referred to the necessity of a comprehensive system in advertising methods, such as is employed by the larger companies, in supplementing their bulletins, circulars, &c., by letters and personal solicitation. He advised advertising in the newspapers, whether they praised the business or condemned it. In the latter case they advertise you, nevertheless, and the public has a capacity for reasoning out things for itself. Newspaper advertising is not merely that of

paid announcements, for central station companies frequently have things happen in connection with their business which would furnish interesting matter for the reading columns. He suggested that part of the money offered to the Association for advertising purposes might be expended in getting up albums containing samples of advertising in the form of circulars, dodgers, follow-up letters, &c., and these circulated from one company to another of the Association membership, such albums being got up and put into circulation once or twice a year."

Evidence of this character will take some getting away from. It must be impressed firmly upon central station managers that they are in competition with business men as well as engineers, and that business methods must be called to aid in capturing new ground and holding it from the enemy. Station costs and total costs are doubtless of importance, but they are only half the story. The other half has yet to be told, at least in this country. You can keep down your coal bill and other charges, but—and don't forget it—advertise.

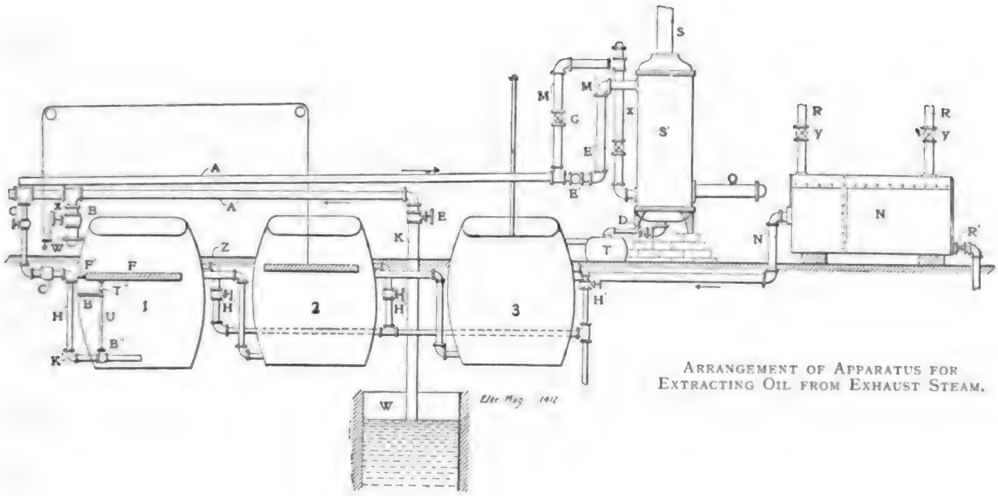
Extracting Oil from Exhaust.

By W. A. DOW.

IN small steam plants where exhaust steam is used for heating purposes, little consideration is paid to the consumption of water or coal, and a record of the maintenance or running expense is seldom kept. The plant is usually run more by guess than by actual figures. About twelve years ago the writer took charge of a plant consisting of a slide-valve engine, one return tubular boiler, a boiler feed pump, a heater and receiving tank for the heating returns, and a small trap. The building was heated in winter by exhaust and live steam. But little thought was given to the economy, and instead of returning the water of condensation to the boiler it was trapped from the receiving tank to the sewer. My predecessor informed me that his reason for doing away with the returns was that he did not feel that it was safe to return it to the boiler on account of the oil in the exhaust steam, and the company would not instal an oil extractor. I thought this a very poor excuse and decided to first get rid of the oil in the returns and then return it to the boiler. The apparatus I used is shown in the accompanying sketch. The exhaust steam enters the heater, S', through the pipe, O, and passes out through the pipe, L, to the heating system, the returns entering the tank, N, through the pipe, RR_1. When the condensation accumulates and partly fills the tank, it runs out by gravity into barrel No. 3, passing out at the bottom and entering barrel No. 2, passing out of No. 2 at the bottom and entering barrel No. 1 at the top. It will be seen that a float is placed in the first barrel and hinged to the side of it at F. A bracket was made fast to the inside of the barrel that acted as a guide to the valve steam, U, shown at B. A joint is placed in the stem at T so that the stem below the bracket can move in a straight line when the float is raised or lowered by the action of the water in the barrel. The thread on a globe valve was filed off, so as to allow the stem free movement in the bonnet of the valve; this acted as a check valve and is shown at B". The water enters the pipe under the valve and is discharged from the top. A check valve was placed in the suction pipe, H, at C, to prevent the water entering the barrel when the city water was used for boiler feed. Water was taken from the well at times, but we did not get good results with this on account of the scale-forming property in it. The city water connection is shown at B and the floor line at Z. Pipes are connected just above the inlet to the barrels, and are also connected to a common blow-down or drain, as shown at H"; as fast as the oil accumulated on top of the water in the barrels it was blown off through this pipe. This kept the water in barrel No. 1 free from oil and perfectly safe to be returned to the boiler.

It is a well-known fact that where heating returns are returned to the boiler very little new water is added to that which is in circulation. It will be seen by tracing the piping that provision is made for this also, in order to have the pump draw from the barrels. The city water must be shut off to relieve the check valve, C', of the 40lb. pressure caused by the tendency of the water to keep it closed. I overcame this obstacle by placing a float in barrel No. 2 and connecting a cord to it, which passed over two pulleys to a lever made fast to the stop valve in the city water main at X.

When the water accumulates in the barrels, as before explained, the float moves upward, allowing the weight, W, to move downward and close the valve, thus shutting off the



ARRANGEMENT OF APPARATUS FOR EXTRACTING OIL FROM EXHAUST STEAM.

water from the city supply. This relieved the check valve, *c*, of the weight on top of it and allowed it to open, the pump forming a vacuum on one side and the atmospheric pressure forcing water out of the barrels into the pump cylinder.

In case the city water was not needed for any length of time to keep up the supply, the cord was disconnected from the lever and the valve, X, closed. It will be seen by the sketch that in a steam plant where all of the water is taken from a well or river that no float will be needed in barrel No. 2. But in any case where the water comes to the pump under pressure, a float or some other arrangement must be used to shut it off while the pump draws the water from the barrels.

The trap was placed between the heater and the barrel, as shown at T, and all condensation that accumulated in the bottom of the heater was also discharged into barrel No. 3. It will be seen that the water comes to the pump warm and is forced through pipe A to the heater at the top, passing through a coil and discharging at the bottom through the pipe, X, to the boiler.

The change resulted in a great saving in the amount of coal used thereafter and reduced the work of the fireman, for under the old conditions of the plant, where cold water was forced through the heater, it was impossible to keep up the steam pressure at times even by forcing the boiler. The pipe, M, is a by-pass, and in case the heater is out of order water is forced to the boiler by opening the valve, G, and closing valves E″ and E′. The exhaust pipe is connected in like manner, but is not shown in the sketch. This change pleased the superin tendent so well that he raised my salary. —*American Electrician.*

*Can a Steam Turbine be Started Quicker than a Reciprocating Engine?**

By A. S. MANN.

If a large steam turbine is cold and at rest, how quickly can it be started? Can it be brought up to speed as readily as can a good cross-compound engine that is cold all over? Most station men would have doubts as to the adaptability of the large turbine, say 1,500kw. or 2,250h.p., for emergency work. The possibilities of an engine with a 62in. low pressure cylinder in starting practically cold and coming up to synchronous speed are well understood. A station manager would criticise an engineer who would open his throttle as fast as he dared without wrecking his piping system and let his machine jump into her work. Most engineers would consider ten minutes as rather a fast start, and fifteen minutes as a more usual starting period, including time taken for warming up.

The station at present under consideration is equipped with three Curtis turbine driven

*Abstract of paper presented at the Scranton Meeting (June, 1905) of the American Society of Mechanical Engineers.

alternators, 40 cycles, 10,000 volts, each of 1,500kw. normal capacity. During the summer months the station is operated as an auxiliary to a water-power plant, taking all sudden overloads. A signal has been arranged, a ¾in. whistle, so that it can be blown instantly should the power fail.

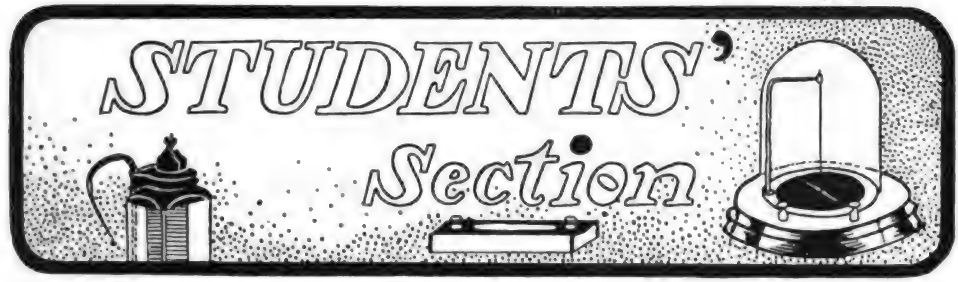
The boiler room has steam up at all times, supplying a system for manufacturing purposes other than power, and slow fires are kept in enough boilers to make steam needed for the normal load.

At the sound of the whistle the water-tender starts a blower on the extra row of boilers; all blast dampers are opened up and all stokers are allowed to feed at the maximum rate. Each fireman dumps his free ash and bars over his red fire. The man in charge of the coal and ash conveyor starts the pressure pump for step bearings. One of the turbine men starts the exciter which supplies current to the auxiliaries beside its field current; a second turbine man starts the circulating pump and then his turbine. The hot well pump and the air pump are started by the oiler. These movements take place simultaneously. The force is organised upon the lines that obtain in a fire station—each man has his specific duty, and after performing it looks to see if there is nothing more for him to do. Only a few seconds elapse between starting the first pump and starting the first turbine. The turbine throttle is opened as fast as an 8in. steam valve can be opened without endangering the steam piping system. It is not considered advisable to open the throttle valve as fast as a man's strength will permit; but if nothing unusual occurs in the pipe line, sentiment does not spare the turbine. One electrician attends to the switchboard and telephone. As soon as the machine approaches speed, the synchronising system is cut in and the main switches are got ready. One and one-half minutes will do the work here outlined, including the time taken in mustering the crew.

Manipulating an engine regulator so that it shall be at a precise speed and at an exact phase relationship from some other machine, not more than $\frac{1}{1500}$ part of a second removed from it is no matter that can be hurried, and one minute is fast time on such work. But the whole thing, phasing-in and all, has been done in two and one-half minutes, including full load on the turbine, which started from a standstill. This performance has been gone through a great many times, and our record book shows that, out of forty-three such calls, ten starts were made in two and one-half minutes, eighteen in three minutes, and fifteen in three and one-half minutes.

The two quickest starts have been made in forty-five seconds and seventy seconds respectively, including phasing-in. These two quickest starts were made on a turbine which had stood for twenty-four hours with the throttle valve shut tight, though there was a slight leakage past the seat. After the throttle valve is off its seat, it is not more than thirty seconds before the turbine is up to speed. A cross-compound reciprocating engine of the four-valve type, 2,250h.p. capacity, can be brought up to speed from a standstill in five minutes if it is hot all over. This five minutes is to be compared with the seventy seconds required for the similar turbine operation.

A reciprocating engine which is turning over slowly with the throttle valve just off its seat or with by-pass open and having all its oil cups open and regulated can be brought up to speed, say seventy-five turns, in two and one-half minutes. This can be compared with the thirty seconds necessary for bringing the turbine up under the same conditions—that is, about one-fifth the time necessary for bringing up the engine. If the engine is cold all over and has all its oil cups shut tight, all its auxiliaries quiet, fifteen minutes is called a rapid start. Starts have been made under such conditions in twelve minutes. When we start a cold turbine, we open up the valve and let her turn, and in two minutes we are ready to bring her up to speed, and she will be at speed in two and one-half minutes, dividing the engine's time by more than four.



Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

How to Calculate Regulation.

Simple Methods of Calculating the Regulation of Alternating Current Circuits.

By J. S. PECK.

ALMOST all engineering specialists have certain short cuts, by the use of which they are able to arrive at approximate results with a speed which to one unacquainted with their methods appears truly marvellous. In the April issue of the *Journal*, Mr. Scott tells "How to Remember the Wire Table," his method being to learn the rules governing the arrangement of the table, and to remember the diameter, weight, and resistance of one size of wire. With this information it is possible to obtain approximately the characteristics of any size of wire, and to make rapid mental calculations.

The determination of the regulation (total drop) of a circuit containing ohmic resistance and self-induction with loads of different power-factors is at first sight a somewhat difficult problem, but by remembering a few simple rules it may be calculated mentally with a considerable degree of accuracy.

CASE I.

To determine the regulation of a circuit containing resistance and self-induction when supplying a non-inductive load.

Rule.—To the ohmic volts in per cent. add the square of the inductive volts in per cent., divided by 200.

Example.—Ohmic volts = 10 per cent.
Inductive volts = 14 per cent.
Power factor of load = 100 per cent.; required the regulation.

Regulation $= 10 \ \frac{14^2}{200} = 11$ per cent.

The reason for this rule may be seen by referring to Fig. 1, from which it is evident that the regulation of the circuit is equal to the difference between line voltage and load voltage, or to the ohmic voltage plus the versine of the angle whose sine is equal to the inductive voltage.

It will be found from trigonometric tables that for small angles the versine varies as the square of the sine, also that the versine of the angle whose sine is .14 is approximately .01 = 1 per cent.; therefore for a sine of .1 the versine is $.01 \times \frac{1^2}{14^2} = .005 = .5$ per cent., and for a sine of .28 the versine is $.01 \times \frac{28^2}{14^2} = .04 = 4$ per cent. Thus, if it is remembered that 1 per cent. is added to the ohmic voltage for an inductive voltage of 14 per cent., the value to be added for different inductive voltages may be calculated easily.

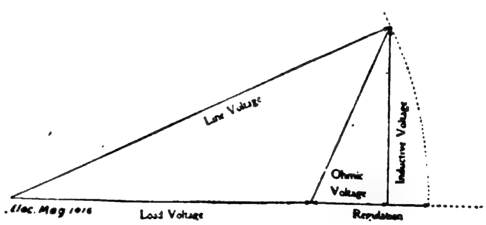


FIG. 1.

The same result is obtained by squaring the inductive voltage and dividing it by 200, as given in the formula. The formula is easily remembered, and enables the regulation of a circuit to be determined quickly and with considerable accuracy.

CASE 2.

To determine the total drop in a circuit containing resistance and self-induction when a load of less than 100 per cent. power factor is supplied.

Rule.—Multiply the ohmic voltage in per cent. by the power factor of the load and the inductive voltage in per cent. by the reactive factor of the load. The sum of the products is the total drop.

The reactive factor is the wattless component of the load, and equals sine $\phi = \sqrt{1 - \text{P.F.}^2}$ where sine ϕ is the angle of lag.

Example.—Power factor = 80 per cent. = .8.
Ohmic voltage = 10 per cent.
Reactive voltage = 14 per cent.; required the regulation.
Reactive factor = $\sqrt{1 - .8^2} = .6$ = 60 per cent.
Regulation = (10 × .80) (14 × .60) = 16.4 per cent.

The construction in Fig. 2 shows the manner in which the rule is deduced.

The regulation is equal to the difference between the line voltage and the load voltage, and it is desired to obtain a simple relation between this drop and the ohmic volts, inductive volts, and power factor. For any but very high power factors the total drop is equal to the sum of the projections of the ohmic voltage and the inductive voltage upon the load voltage.

The projection of the ohmic voltage on the load voltage = ohmic voltage × (cosine ϕ power factor).

The projection of inductive voltage on load voltage = inductive voltage × (cosine $[90° - \phi]$ = reactive factor). Therefore the regulation = ohmic drop × power factor ; reactive drop × reactive factor.

By remembering the reactive factor for certain power factors, the regulation of a circuit may be calculated mentally and without the use of charts or tables of any kind.

The reactive factors for a few of the most common power factors are given in the table following :

Power-factors. cos ϕ	Reactive factors. sin ϕ
95 per cent.	31 per cent.
90 per cent.	43 per cent.
85 per cent.	53 per cent.
80 per cent.	60 per cent.
70 per cent.	70 per cent.
60 per cent.	80 per cent.

A consideration of these values in connection with Rule II. indicates that for power factors above 70 per cent. the ohmic voltage has relatively a greater effect upon the regulation than has the inductive voltage, while for 70 per cent. power factor they have relatively equal effects, and for power factors less than 70 per cent. the inductive voltage has relatively greater effect than the ohmic

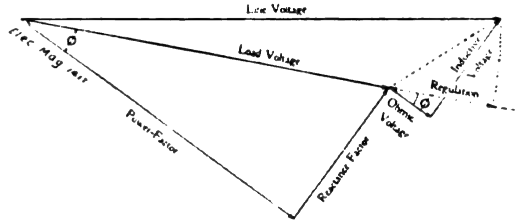


FIG. 2.

voltage upon the regulation. This last point brings out the fact that where the ohmic voltage is greater than the inductive, the regulation is better with a very low power factor than with a high one.—*Electric Journal.*

How to make an Electric Buckboard.

By J. C. BROCKSMITH.

[*Enterprising students who follow these instructions carefully, and are in a position to construct the vehicle described, will become the proud possessors of a handy runabout for town use as well as an example of their ingenuity and skill.*—ED. *E. M.*]

THE vehicle here described is of the buckboard type, in which the necessary cushioning effect, usually obtained by means of springs, is secured, partly through the resiliency of the tyres and partly through the use of a frame or platform which gives a considerable elastic deflection under load. This permits of dispensing with springs, and results in a much simpler and lighter construction all the way through.

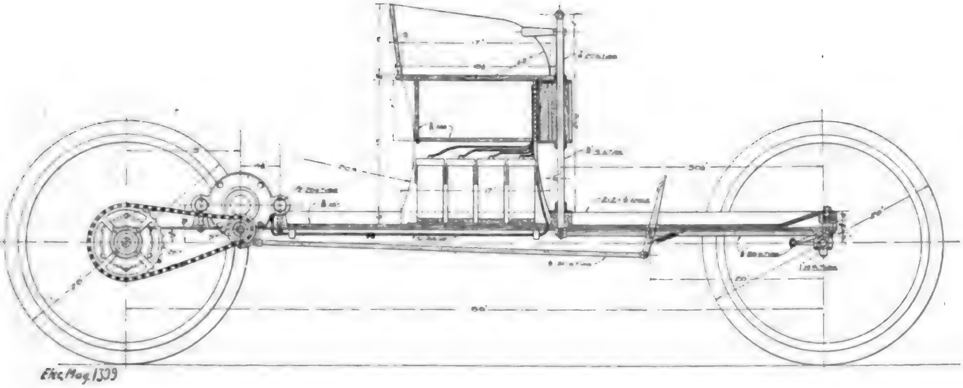


FIG. 1.

A single motor is used in connection with a differential or balance gear of simple construction on the rear axle. Owing to the extreme lightness of the vehicle and the consequent small power required to run it, it would be inadvisable to subdivide the power into two units with a resulting loss in efficiency. The battery used consists of twenty double cells, each having a capacity of twenty ampere-hours, thus giving eighty volts and twenty ampere-hours when coupled in series.

The controller provides three forward speeds of 3½, 7, and 12-14 miles, and a slow speed reverse of 3½ miles per hour with the normal gear ratio. At the normal speed of 12-14 miles per hour, the machine is capable of running thirty-five to forty miles on one charge of the battery, over good roads. With a change of driving sprocket any speed up to 20 or 25 miles per hour can be obtained without exceeding the one hour discharge rate of the battery. Higher speeds than the normal are only obtained, of course, at the expense of efficiency, which results in a lower mileage due to the high discharge rate of the battery.

The outfit is designed particularly for city use over well paved streets, and with this in view the weights of the various parts have been reduced to the lowest possible limits. The weights of the various items and of the complete vehicle are as follows:

	lbs.
Motor	38
Battery	170
Running gear	122
Woodwork	45
Total	375

THE RUNNING GEAR.

Fig. 1 is a sectional elevation of the complete buckboard and shows the mounting of the motor on the frame together with the method of driving by means of gears and chain reduction to the rear axle. Fig. 2 illustrates the completed machine.

The wheels are 28in. in diameter, provided with 2in. single-tube "motor

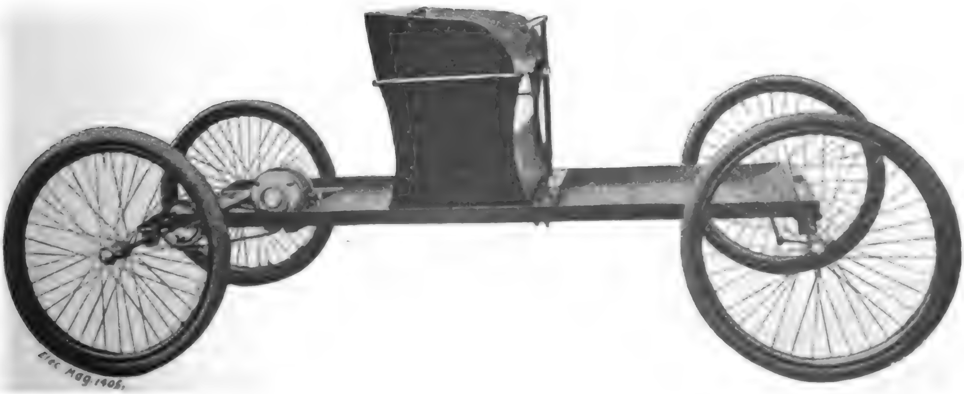


FIG. 2.

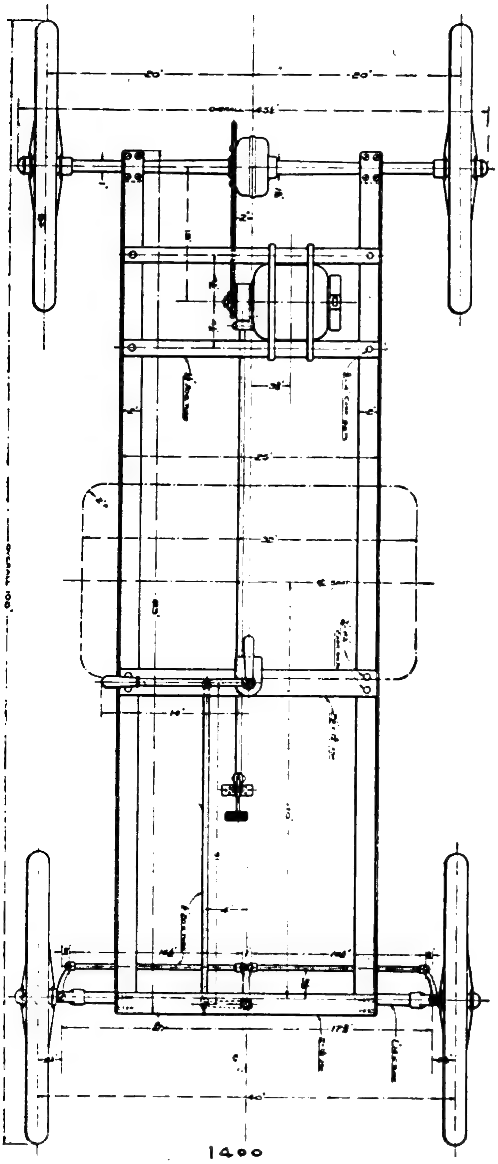


FIG. 3.

cycle" tyres and have thirty-six and forty spokes of 12 and 14 gauge. The rims are of 28 × 2in. maple. The "body" consists merely of a seat accommodating two persons, the space underneath being divided into two compartments by a horizontal shelf. The lower compartment is for four battery trays, while the upper compartment may be utilised for storing a tyre pump, charging cable and such tools and accessories as may be required.

The controller is a small semi-cylindrical affair mounted on the front of the seat. The steering rod passes up through the controller cylinder and terminates in a steering handle or bar at a convenient distance above the floor line, the controller itself being operated by means of a smaller handle located concentrically with and just underneath the steering handle. The brake pedal is located within easy reach of the driver's foot and connects with a brake shoe working on a drum on the motor counter-shaft, which, being geared, as it is, to the rear axle in the ratio of about 3 to 1, makes a very effective brake. As an extra precaution in case of emergency, the motor may be run in the reverse direction, but this is not advisable ordinarily, as it puts a severe strain on all the transmitting parts.

It is hardly advisable to instal any electrical instruments on a vehicle of this description, as it increases the cost and also the wiring complications. It is well to have a small cyclometer of the "trip" type on the front wheel; this will enable the operator to keep within the known mileage capacity of his battery. It is useful to test the vehicle when first completed for speed, current consumption, &c.; but after such data are obtained there is nc further necessity for having instruments on the machine.

The tests should show up about as follows:

Controller.	Volts.	Amps.	Speed. M.P.H.
1	21½	5½	4½
2	41	7	9
3	80	9	15

Fig. 3 is a plan view of the chassis and shows the steering and brake connections, together with the motor suspension and drive, somewhat more plainly than in the previous figure.

The two side members of the frame are composed of 2 × 2 × ⅛in. steel angles. These are figured to work well up to their elastic limit under load and consequently give a considerable elastic deflection which contributes to ease of riding. The angles are cut off 83in. long, and are drilled at each end for four $\frac{5}{16}$in. machine screws, which fasten on the axle bearings. They are also drilled and tapped at intervals to fasten the flooring, which is laid directly on the lower flanges of angles and secured by means of 10.24 flat head machine screws tapped into the metal.

(To be continued next month.)

WIRE-MEN'S Electric Light & Power Wiring Section Artisans

Wiremen and Artizans should refer to the World's Electrical Literature Section for classified list of articles on subjects of importance to themselves.

Wiremen and the New Lamps.

(Owing to pressure on our space this section is curtailed this month.)

It is a mere platitude to say that electric lamps, especially incandescent lamps, have undergone little change during the twenty-five years of their use. But there are indications of change now, indications which have every promise of a practical issue shortly. The carbon filament lamp is now being subjected to numerous interesting experiments : filaments rated below normal working voltage are inserted in specially large bulbs and fitted with reflecting devices to utilise every illuminating ray. These lamps are now marketed by most makers, and each has its particular "so-and-so lite" designation. The Nernst lamp has now, of course, become quite an old stager, but this fact should be no deterrent to a study being made of its characteristics by wiremen. Indeed, the Nernst lamp is such a bundle of paraphernalia that it requires some little time and thought to grasp the co-ordination of its details. The new metal filament incandescent lamps, of which the most important is the tantalum lamp, are decidedly interesting and pregnant with possibilities in the immediate future. Lamps of this class materially reduce the energy required for lighting purposes. The 100 volt lamps, which are as far as we know the only type manufactured, require at a rate of 1.8 to 2.5 watts per candle, or about half the energy consumed by the ordinary carbon filament lamp. From experiments made in the large testing laboratories of America and Germany the life of these lamps is quite comparable with that of standard carbon lamps, and up to 600 hours the illumination is well maintained. Some American central station men even aver that it will be cheaper to buy tantalum lamps for their economical propensities than to receive carbon filament lamps free.

It must not be supposed, however, thatthe carbon filament will soon "go bust." Interesting experiments have been made by the General Electric Co. (America) in heating a treated filament to a high temperature in the electric furnace. This process seems to convert the shell of the filament into a new form of graphite, and the resultant filament can be operated at 2½ watts per candle efficiency, its temperature coefficiency of resistance being positive. The filament is shorter than in the ordinary lamps, but the life is longer, and the makers anticipate an even higher efficiency from experiments now being conducted.

In the arc lamp world the enclosed lamp seems to be giving very encouraging results, and the new flame lamps are also meeting with a good reception. They are to be seen replacing numerous incandescents in open spaces, while for shop lighting, both interior and exterior, they have considerable vogue.

It behoves wiremen to obtain all possible particulars of these new developments. They will find it a very good plan to keep either a small file of articles describing these improved devices or to make up a scrap book in which cuttings from the electric Press are pasted. For immediate personal reference the salient facts can be epitomised in few pages of a note-book and carried in the pocket. We hope to publish a comprehensive article dealing with these developments for wiremen's special use in a near issue.

Municipal Wiring.

THE Electrical Contractors' Association held its annual dinner recently, and among the speakers at the feast was the Clerk to the L.C.C., Mr. G. L. Gomme. As a representative of a great corporate body Mr. Gomme had naturally something to say about municipal interests, more especially in respect to their influence for good or ill on electrical contractors. He said "contractors in the electrical world as contractors elsewhere are doing wrong to themselves and hence wrong to municipalities, when they suggest that the field of work which we are taking in hand for the good of the community is injuring them. I am one of those who believe that extending work in any direction is extending trade." The Mayor of Shoreditch, however, had a doleful tale to tell of municipal dabbling in wiring in his borough, the scheme which was to have done so well being abandoned after a fair trial. The Mayor himself had naturally little faith in municipal wiremen because a fire occurred in his own house as the result of their labours. After this confession of faith, Mr. W. R. Rawlings, ex-President of the Association, could understand Mr. Gomme's belief that contractors would benefit by municipal wiring.

The L.C.C. Bill has reached the Upper House, and the *Electrical Review*, commenting editorially on the situation, invites the whole trade to rally round the Association, and oppose what it considers to be an objectionable form of municipal trading.

Careless Handling of D.C. Motors.

THE following hints, contributed to the *American Electrician* by Mr. W. G. Viall, should be taken to heart and acted upon in case a similar example should be encountered. The writer's attention was recently attracted to the instruction card got out by a central station for the purpose of instructing anyone whose duty it might be to start and stop any of the motors owned by the company and rented to its customers. Most of the motors were of the Edison bi-polar type and were operated on 500 volt current; wattmeters were used on nearly all the motors. The single-pole switch referred to in the instructions is mounted on the terminal board of the motor and is used for opening the armature circuit only. The principal feature of this case is the instruction card, particulars of which are as follows—

TO START MOTOR.

FIRST.—See that resistance is all in. SECOND.—Close double-pole switch. THIRD.—Close single-pole armature switch. FOURTH.—Turn out resistance slowly.

CAUTION.

Never put a load on the motor until the resistance is all out.

TO STOP MOTOR.

FIRST.—Open single-pole armature switch. SECOND.—Open double pole switch. THIRD.—After motor has stopped turn in resistance.

CAUTION.

Never allow motor to stand with brushes off of the armature. Cost of repairs caused by not following above directions will be charged to the user.

The instructions for starting the motor are all right, as the field is allowed to build up to a considerable extent before current is applied to the armature by closing the single-pole switch. It is in the instructions for stopping the motor where the fault lies. Opening the single-pole switch first will cut out the armature and leave the field alive; then when the main or double-pole switch is opened the field circuit will be broken quickly and the reactive kick of the field coils will cause a sudden rush of current through the meter, under a voltage many times greater than the normal running voltage. The result will be a burned-out, short-circuited or open-circuited pressure coil in the meter, and should there happen to be no meter in the circuit to take up the discharge, the voltage might rise to an instantaneous value sufficiently high to break down the field insulation and ruin the field coils. The first thing to be done in stopping the motor, of course, is to open the main switch, and after the motor stops the single-pole switch should be opened and the starting resistance cut in. By stopping in this way the field and armature would be connected with each other until the motor stops running, and from the instant the main switch is opened the motor will act as a dynamo and supply current to the field from the armature; as the armature gradually comes to a stop the field current gradually diminishes, so that when the single-pole switch is opened no current will be flowing in the field circuit.

The World's ELECTRICAL LITERATURE

You should carefully study this Section, as it will save you much valuable time. It is the key to the world's monthly Electric Progress.

Power.

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Hydro-Electric Power Station at Ladermier. S. Herzog.	*Elec. Wld. & Engr.* 10/6/05.
Niagara Power in Toronto.	*Elec. Wld. & Engr.* 24/6/05.
Transmission of Niagara Power to Toronto.	*Elec. Wld. & Engr.* 1/7/05.
Regulation and Efficiency of Transmission Lines. H. Pender	*Elec. Wld. & Engr.* 1/7/05.
Colorado Springs Electric Co. E. B. Dillon.	*Elec. Rev., N.Y.* 10/6/05.
Fundamental Features of Electric Elevators. C. R. Carichoff.	*Elec. Rev., N.Y.* 24/6/05.
High Power Gas Engines in German Electric Power Plants. F. C. Perkins.	*Elec. Rev., N.Y.* 1/7/05.
Electric Driving of Rolling Mills.	*Electn.* 16/6/05.
Considerations Governing the Choice of an Electric Motor. A. Stuart.	*Elec. Power.* July/05.
Bournillon (Isère) 35,000 Volt Station. A. Soulier.	*L'Ind. Elec.* 10/7/05.
Experiences in the Transmission of Three-Phase Current at 30,000 Volts. L. Drugbert.	*Rev. de L'Elec.* 1/7/05.
Proposed Municipal Lighting for New York City.	*Elec. Wld. & Engr.* 8/7/05.
Transmission of Power from Niagara to Toronto.	*Elec. Wld. & Engr.* 8/7/05.
The Supply of Electric Power to London. A. Britton.	*Elec. Wld. & Engr.* 8/7/05.
Some Features of the Central Station at Zwolfmalgarien. A. Stevens.	*Amer. Elec.* July/05.
Individual v. Belt Drive in Electrically Operated Shops. P. A. Bates.	*Amer. Elec.* July/05.
Electrical Power Developments in Mexico. F. O. Blackwell.	*Cassier's Mag.* July/05.
Personal Recollections of the Rise of the Electrical Industry. Elihu Thompson.	*Engineering Mag.* July/05.
Shunt Motors for Electric Cranes. C. W. Hill.	*Elec. Rev.* 14/7/05.

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High Potential Oscillations of High Power in Large Power Distribution Systems. C. P. Steinmetz.	*Amer. I.E.E.* 19/6/05.
A Study on Commercial Transmission Lines of the Rise of Potential due to Static Distribution, such as Switches, Current, &c. P. T. Thomas.	*Amer. I.E.E.* 19/6/05.
Water Power of the South-Eastern Appalachian. F. A. C. Perrine.	*Amer. I.E.E.* 22/6/05.
Development of the Ontario Power Co. T. N. Nunn.	*Amer. I E.E.* 22/6/05.

Traction.

Articles.

New Valtellina Electric Locomotive.	*Elec. Rev., N.Y.* 24/6/05.
Repairing Steel Motors and Other Electrical Shop Notes. A. B. Weeks	*Strt. Rly. Jrnl.* 10/6/05.
Field v. Armature Nearest Trolley. J. Andrews.	*Strt. Rly. Jrnl.* 1/7/05.
Car Designs and Carrying Capacity. J. P. Fox.	*Strt. Rly. Jrnl.* 1/7/05.
Motor Men's School System in Brooklyn.	*Strt. Rly. Jrnl.* 17/6/05.
A New System of Signalling on the Midland Railway.	*Electn.* 23/6/05.
Electric Traction by One-Phase Alternating Currents. L. Gratz Muller.	*L'Ind. Elec.* 22/6/05.
Steel Wheels for Street Railway Service. G. L. Fowler.	*Strt. Rly. Jrnl.* 17/6/05.
Elevated Construction in Paris and Berlin. J. P. Fox.	*Strt. Rly. Jrnl.* 24/6/05.
Trolley Standards. Their Liability to Become Dangerous to the Public and Some Devices for Rendering them Safe. P. J. Pringle.	*Elec. Eng.* 14/7/05.
Portable Sub-Station for Cincinnati and Columbus Traction Co. J. R. Hewitt.	*Strt. Rly. Jrnl.* 8/7/05.
Suitable Cranes for City and Suburban Services. T. W. Wilson.	*Strt. Rly. Jrnl.* 8/7/05.
The Wheel Question. C. G. Bacon.	*Strt. Rly. Jrnl.* 8/7/05.

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*Three-Phase Traction. F. W. Waterman (*see* "Traction" this month).	*Amer. I.E.E.* 20/6/05.
*Heavy Electric Freight Traction. C. de Muralt.	*Amer. I.E.E.* 20/6/05.
*Choice of Motors in Steam and Electric Practice. W. McLellan.	*Amer. I.E.E.* 20/6/05.
Electrical Features of Block Signalling. H. H. Thullen.	*Amer. I.E.E.* 20/6/05.
*Weight Distribution on Electric Locomotives, as Effected by Motor Suspension Drawbar Pull. S. T. Dodd.	*Amer. I.E.E.* 20/6/05.
Train Despatching. O. P. Spillman.	*Ind. Elec. Rly. Assoc.* 8/6/05.
*Charges for Supply from Combined Lighting and Traction Stations. J. H. Rider.	*Mun. Trmys. Assoc.* 3/7/05.
Rules and Regulations for Tramway Employés. H. E. Blain.	*Mun. Trmys. Assoc.* 4/7/05.
Motor Buses v. Electric Tramcars. W. A. Luntley.	*Mun. Trmys. Assoc.* 4/7/05.
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Publicity. J. H. White.	*Strt. Rly. Conv. N. Y. States.* 27/6/05.

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*Potential Regulation based on the Different Resistance Behaviour of Carbon and Tantalum Lamps. A. E. Kennelly and S. E. Whiting.	*Elec. Wld. & Engr.* 1/7/05.

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Incandescent Lamps. A. B. Lamb.	*Canadian Elec. Assoc.* 23/6/05.
*Constant Current Mercury Arc Rectifier. C. P. Steinmetz.	*Amer. I.E.E.* 19/6/05.
*A New Carbon Filament. J. W. Howell.	*Amer. I.E.E.* 22/6/05.
Street Lighting. E. E. Hoadley.	*I.M.E.A.* 27/6/05.

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New Automatic Telephone Exchange at Columbus.	*Elec. Rev., N.Y.* 17/6/05.
The Typo Telegraph. A. J. Swift.	*Elec. Rev., N.Y.* 24/6/05.
The Use of the Telephone by the Japanese at the Battle of Mukden. M. C. Sullivan.	*Elec. Rev., N.Y* 1/7/05.
The Work of Scudamore. R. Appleyard.	*Elec. Rev.* 23/6/05.
Co-operation of Manual Systems and Strowger Automatics. F. Lubberger.	*Telep. Mag.* June/05.
Modern Telephone in Theory and Practice. W. Radcliffe.	*Telep. Mag.* June/05.
Systems for Rural Lines Service. W. Taylor.	*Sound Waves.* June/05.
Necessity for Ground Wires. G. W. Wilder.	*Sound Waves.* June/05.

Efficient Lightning Protection. A. E. Dobbs.	*Sound Waves.* *June*/05.
Practical Management of Maintenance and Operation. C. E. Stintson.	*Sound Waves.* *June*/05.
Submarine Signals. G. Dary.	*L'Electn.* 8/7/05.
Modern Telephone Cables. C. E. Krarup.	*Jnl.Télégraphique.* 25/6/05.
Telegraphs and Telephones in Russia in 1902.	*Jnl.Télégraphique.* 25/6/05.
Telephone Construction Practice. H. J. Mehinnick.	*Telephony.* *June*/05.
Concerning Party Line Switching. S. G. McMeen.	*Telephony.* *June*/05.
Ordinary Telephone Construction. J. L. W. Zietlow.	*Telephony.* *June*/05.

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Combined Telegraphy and Telephony. J. McMeen.	*Nat. Ind. Tel. Assoc.* 20/6/05.
Standard Toll Signs. W. G. Laubach.	*Nat. Ind. Tel. Assoc.* 20/6/05.
Value of Telephone Securities A. B. Greenshields.	*Nat. Ind. Tel. Assoc.* 20/6/05.

Electro-Physics.

Articles.

Application of the Braun Cathode Ray Tube. V. M. Varley and W. H. F. Murdoch.	*Electn.* 16/6/05.

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Comparison of Electric Fields by Means of Oscillating Needle. D. Owen.	*Phys. Soc.* 30/6/05.

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The Development and Present Status of Cyanidation in the United States. W. H. Davis.	*Elec. Chem.* *July*/05.
An Autogenous Lead Soldering. M. U. Schoop.	*Elec. Chem.* *July*/05.
Metallurgical Calculations. V. J. W. Richards.	*Elec. Chem.* *July*/05.
Electrolysis with Alternating Currents. Le Blanc.	*German Bunsen Soc.* 2/6/05.
Tantalum and the Tantalum Lamp. Dr. von Bolton.	*German Bunsen Soc.* 2/6/05.
Accumulator Cells without Lead. Prof. Elbs and Dr. Grafenberg.	*German Bunsen Soc.* 2/6/05.
Oxidation of Nitrogen by Spark Discharge. Dr. Brode.	*German Bunsen Soc.* 2/6/05.
Electrode Potentials. Prof. Luther and Dr. Kruger.	*German Bunsen Soc.* 2/6/05.
Oxidation of Palladium. Dr. Wöhler.	*German Bunsen Soc.* 2/6/05.
Magnetic Compounds from Dia-Magnetic Substances. Dr. Wedeking.	*German Bunsen Soc.* 2/6/05.

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Electro-Chemical Industries of Niagara Falls. J. S. A. FitzGerald.	*Amer. Chem. Soc.* 22/6/05.

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New Underground Cable System. Alex. Huttman.	*Elec. Wld. & Engr.* 10/6/05.
Some European H. T. Switchboards. F. Niethammer.	*Elec. Wld. & Engr.* 17/6/05.
*Booster Field Control. C. P. Nachod.	*Elec. Wld. & Engr.* 24/6/05.
Characteristics of a Holtz Machine. H. Dingle and J. S. Knowlson.	*Elec. Wld. & Engr.* 24/6/05.
*Electric Spark Recorder. F. W. Springer.	*Elec. Wld. & Engr.* 1/7/05.
*A Method of Calculating Core Lines in Large Alternators. T. S. Allen.	*Elec. Wld. & Engr.* 1/7/05.
The Design of Transformers. A. Press.	*Elec. Rev.* 16/6/05.
Notes on Iron Loss. F. Lydall.	*Elec. Rev.* 23/6/05.
Rational Construction of Tesla Transformers. P. Drude.	*Rev. de l'Elec.* 8/7/05.
Riedler-Stumpf Steam Turbines. E. Guarini.	*Rev. de l'Elec.* 8/7/05.
Hysteresis of Magnetic Substances in Revolving Fields under the Action of Continuous Current Interrupted, Alternate, and Herzian Waves. R. Arno.	*L'Ind. Elec.* 10/7/05.
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Calculations for the Shaft, Gear, and Bearings of Crane Motors. G. J. Leire.	*Machinery, N.Y.* *July*/05.
Single Phase Induction Regulator. G. B. Bergman.	*Elec. Wld. & Engr.* 8/7/05.

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Organisation and Administration of National Engineering Societies. J. W. Lieb.	*A.I.E.E. An. Con.* 19/6/05.
Limits of Injurious Sparking in Direct Current Commutation. T. Reid.	*Amer. I.E.E.* 26/6/05.
A Study in the Design of Induction Motors. C. A. Adams.	*Amer. I.E.E.* 26/6/05.
Limitations in D.C. Machine Design. S. Senstius.	*Amer. I.E.E.* 26/6/05.
Motor Generators and Synchronous Converters. W. L. Walters.	*Amer. I.E.E.* 26/6/05.
A New Instrument for Measuring Alternate Currents. E. F. Northrup.	*Amer. I.E.E.* 26/6/05.
Eddy Currents in Large Slot Wound Conductors. A. B. Field.	*Amer. I.E.E.* 26/6/05.
A New Induction Generator. W. Stanley.	*Amer. I.E.E.* 22/6/05.
A Simple Device for Finding the Slip of an Induction Motor. C. A. Perkins.	*Amer. I.E.E.* 22/6/05.

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*Electricity Meters. C. H. W. Gerhardi.	*Electn.* 23/6/05.
Commercial Management of Municipal Electrical Supply. T. W. Sheffield.	*Elec. Rev.* 16/6/05.
Diversity Factor and its Influence on Motor Load Charges. A. M. Taylor.	*Elec. Rev.* 23/6/05.
A Novel Circuit Breaker Alarm. R. N. Tweedie.	*Elec. Rev.* 23/6/05.
Electricity in Brazil. W. W. Galey.	*Elec. Rev.* 23/6/05.
The Starting of Induction Motors. F. Lewis.	*Elec. Rev.* 30/6/05.
Flue Gas Analysis. F. H. Corson.	*Elec. Rev.* 14/7/05.
Boiler Feed Apparatus. C. L. Hubbard.	*Amer. Electn.* *July*/05.
City Refuse as Fuel in Electric Plants. G. E. Walsh.	*Amer. Electn.* *July*/05.
Modern Steam Traps. W. T. Edwards.	*Amer. Electn.* *July*/05.
Choosing an Engine for an Isolated Plant. A. S. Knowlton.	*Cassier's Mag.* *July*/05.
Inspecting Electrical Plants for Fire Risk. G. L. Clark.	*Cassier's Mag.* *July*/05.
The Effects of Vacuum on Steam Engine Economy. R. N. Neilson.	*Engineering Mag.* *July*/05.
Methods and Suggestions for the Starting of Gas Engines. R. E. Mathot.	*Engineering Mag.* *July*/05.

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Effects of Frequency and Voltage on Transformers. S. A. Sammett.	*Canadian Elec. Assoc.* 23/6/05.
Selection and Maintenance of Service Motors. W. Bradshaw.	*Canadian Elec. Assoc.* 23/6/05.
Operation of Alternators in Parallel. A. L. Mudge.	*Canadian Elec. Assoc.* 23/6/05.
Notes on Steam Engines and Boilers. W. Mackay.	*Canadian Elec. Assoc.* 23/6/05.
Data Relating to Electric Conductors and Cables. H. W. Fisher.	*Amer. I.E.E.* 19/6/05.
Measurement of High Pressure Currents. S. M. Kintner.	*Amer. I.E.E.* 19/6/05.
*Load Factor, Its Effect upon Electricity Stations. A. Sinclair.	*I.M.E.A.* 27/6/05.
*Notes on Costs and Tariffs for Electric Supply. H. Kilgour.	*I.M.E.A.* 28/6/05.
The Supply of Electricity in Municipal Areas from a Municipal Point of View. W. Hodgson.	*I.M.E.A.* 28/6/05.
*Extensions to Outlying Areas. A. B. Mountain.	*I.M.E.A.* 30/6/05.
*Electricity Supply by Free Wiring and Prepayment Meters. A. R. Sillar.	*I.M.E.A.* 30/6/05.

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Articles.

Electrical Engineering at the Kyoto Japan Imperial University.	*Elec. Wld. & Engr.* 17/6/05.
The Training of Engineers and National Stability. R. Brown.	*Elec. Rev.* 14/7/05.
Rules Giving the Direction of Rotation and Field and Rotor of a Polyphase Motor. W. P. Maycock.	*Elec. Rev.* 14/7/05.
How to Make an Electric Buckboard. J. C. Brock Smith.	*Amer. Elec.* *June-July*/05.

Wiremen.

Articles.

Careless Handling of D. C. Motors. W. G. Viall.	*Amer. Elec.* *July*/05.
Diseases of Electrical Machinery. S. S. Crocker and J. Wheeler.	*Amer. Elec.* *July*/05.

"*Die Elektrischen Druckknopfsteuerungen für Aufzüge.*"

(Push-Button Controllers for Electric Lifts.) By A. GENZMER. Hanover: Gebrüder Jänecke. Price M. 5.

The author of this work has performed a most useful service by bringing together within the small compass of 166 pages a very large amount of information regarding electric lifts in general, and automatic lift controllers in particular—information that has hitherto been scattered in a large number of not always easily accessible technical journals. The theory, design and construction of the various parts of an automatic control system are dealt with in a thorough and systematic way, and the concluding sections of the book are devoted to a descriptive account of various German automatic control systems for electric lifts. The book may be recommended to all interested in the subject, and should prove particularly useful to architects and builders, whose knowledge of such matters is frequently very imperfect.

"*Elektrische Traktion.*"

(Electric Traction.) By G. SATTLER. Hanover: Gebrüder Jänecke. Price M. 4.20.

In this little volume of 158 pages the author wisely refrains from giving too much purely descriptive matter, and devotes most of the space at his disposal to the determination of the power required to work tramway systems, the design of the feeders and trolley wires, methods of testing, track construction, details of overhead construction, and costs. One chapter is devoted to electric automobiles. The treatment, although necessarily condensed, is very lucid, and we can warmly recommend the work to traction engineers.

"*Elektrisch Betriebene Krane und Aufzüge.*"

(Electrically-driven Cranes and Lifts.) By S. HERZOG. Zürich: Albert Raustein. 1905. Price fr. 30.

The application of electric power to the driving of cranes and lifts has made enormous strides during the last few years, and, in spite of the keen competition of rival methods, is steadily gaining ground. As in the case of all the rapidly growing branches of technical science, the literature of the subject has considerably lagged behind the actual developments, and it has been by no means an easy matter to obtain accurate information on many of the technical details connected with the design and working of electric cranes and lifts. This want has now been supplied by the excellent treatise under review—a treatise regarding which we may at once say that it is our ideal of what such a treatise ought to be. The subjects dealt with are handled in a masterly fashion, and for thoroughness and comprehensiveness there is at present no other book on the subject—either English or foreign—that can compare with it for a moment.

The first few sections of the book deal with motors, controllers, toothed and worm gearing, and couplings. The characteristics of the various types of motors, their efficiencies, dimensions, and weights, are considered very thoroughly. In dealing with the subject of controllers the author gives numerous detailed diagrams of the more important types. Similar fulness of treatment characterises the sections on gearing and couplings. The important subject of brakes is next dealt with, and this is followed by sections on bearings, ropes, chains, hooks, and winding drums. The next section, which occupies nearly a quarter of the entire book, is devoted to overhead travelling cranes, and is followed by shorter sections dealing with other forms of cranes, such as movable, revolving, dock cranes, &c. The concluding section deals with electric lifts.

To electrical engineers whose work is connected with electric cranes or lifts the treatise under review should prove of exceptional value. Among the many excellent features which characterise it we may draw special attention to the detailed model specifications, and to the numerous beautifully executed scale drawings. The book is not disfigured by any ugly reproductions of poor photographs, such as are a painfully prominent feature of many books "made to order" in this age of hurry. The publishers deserve the highest credit for the extreme care which they have evidently bestowed on the book. It is sumptuously printed in large Roman type on paper of the best quality, and the general "get-up" of the book is in every way worthy of the thoroughness which characterises the author's treatment of his subject.

"*Telegraphie und Telephonie ohne Draht.*"

OTTO JENTSCH. Berlin: Julius Springer. 1904.

This book gives a very comprehensive account of wireless telegraphy from the early experiments of Steinheil, Morse, Gale, and Lindsay, to the well-established systems and commercial work of the current time. It is also well printed and profusely illustrated, a feature, indeed, which is indispensable in a work of this description, and which lends itself to a quick and intelligent appreciation of the subject matter. The author is Chief Inspector of Postal Telegraphs at

the headquarters in Berlin, and his official position in Germany has enabled him to obtain an accurate acquaintance with all that has been done in that country in the sphere of wireless telegraphy, as well as in other branches of the science. His review is not, however, confined to Germany, for less than a third of the book is devoted to the achievements of workers in that country, while he gives fair and impartial consideration to the valuable progress made in other parts of Europe, as well as in America.

In addition to the experiments associated with the first half of the last century, and the investigations of Faraday and of Maxwell, the author briefly touches upon the devices of Bourbouze in Paris, during the siege; of Loomis in Virginia; of Rathenau in the Wannsee, near Berlin; of Strecker in Brandenburg; and of Orling and Armstrong. Between the years 1880 and 1891 Trowbridge was experimenting in the United States with an electro-magnetic system, and was enabled to bridge a distance of one kilometre with the inductive action of an alternating current generator. Preece's system, evolved in the year 1882, which marks an historical epoch in Great Britain, led to the establishment of communication, by lateral induction, between Lavernack Point and Steep Holm, a distance of 8.6 kilometres. Willoughby Smith and Granville conceived the idea of bridging over a gap between two cables ending in earth plates by direct signals from a strong battery, which were caused to affect a mirror galvanometer. Mention is also made of Stevenson, Evershed, and Phelps, who employed inductive means to signal through sea water and air. Edison's patent of 1885, which was applied in the year 1889 on the Lehigh Valley Railroad, appears to the author to cover the method of communication by static induction, which was, in this instance, practically employed between the metal roof of the railway waggons and the contiguous wire on telegraph posts, and has an important bearing upon the claims of other inventors put forward in later years. Dolbear's attempts to communicate by telephone with the aid of aërials, with added capacity at the upper extremities, resulted favourably over a distance of one kilometre, but did not take practical shape. Oliver Lodge's application of the principle of syntony receives recognition from the author, and, indeed, he is in all cases ready to do justice to all the distinguished scientists of various nationality who have assisted in furthering a science which could not, without their combined and enthusiastic labours, have made such rapid strides as ætheric telegraphy has done. Following upon the researches of Hertz into the properties of ultra-violet rays, Zickler, in Germany, and Sella, in Italy, in the year 1898, devised apparatus for the transmission of signs by the use of these rays. The former operated over a distance of five kilometres. The author shows how great an advance in the science was rendered possible by the discovery by Hughes of the phenomena attending imperfect contacts, by Hertz's experimental verification in the years 1886-1889 of Maxwell's theories, and by the invention of Branly's wave-detector in the year 1891, at Paris. It was with this device that Popoff, in 1895, worked his wireless system at Kronstadt in conjunction with "antennæ." Marconi, who had been working in Italy with the Righi oscillator and Popoff's antennæ, came to England, and, with Preece's assistance, carried out some experiments at Lavernack Point, in the Bristol Channel, in 1896. This was the beginning of his great achievements. In 1897 he was able to transmit signals over a distance of sixteen kilometres in the Gulf of Spezia. To avoid disturbances with other stations in the same vicinity Marconi next adopted the regulation of the wave lengths, or the principle of syntony which had been advocated by Lodge. The author gives credit to Slaby for having theoretically established this principle in the year 1900, or even earlier. In the former year he displayed before the German Emperor the working of tuned systems between the office of the Allgemeine Company and Charlottenburg (four kilometres) on the one hand, and the Oberspree works (fourteen kilometres) on the other.

The priority of invention of the closed oscillating circuit with inductive excitation is awarded to Braun, in view of his patent of October 14th, 1898, and his use of this system at Strasburg in the same year. About the same time Slaby and Arco were associated at Potsdam in working out the system which bears their names, and with which a distance of 800 kilometres was finally coped. The "Telefunken" has combined the interests of the Slaby-Arco and Braun-Siemens systems.

Due place is given to the modes adopted in France on the systems of Blondel, of Branly-Popp, and of Popoff-Ducretet, in Belgium by Guarini, to the interesting attempt by Artom, in Turin, to render signalling possible by the use of polarised waves, and of Arno's wave detector.

Coming to England, reference is made to the work of Preece and Gavey in the Menai Straits and the North of Ireland, to Duddell's achievements with the tuned arc, and to the wave detector of Ewing and Walter. Some pages are given up to a description of the Lodge-Muirhead system, which has met with considerable success and is, it is believed, the only system at present working in the East.

A clear exposition is given of the principles of Tesla's, deForest's, and Fessenden's systems. The account of the deForest arrangement as used in the present war in the East is not, of course, included, as the book was at that time in the press, but the author acknowledges the great suitability of the electrolytic "responder," and the fact that a speed of forty words per minute had been reached by deForest at the time when his description was written. It is considered also that the detector of Fessenden, embodying the principle of the holometer, is likely to give important results.

Jentsch's book will be found very useful to students, and to all who wish to gain a comprehensive knowledge of wireless systems, and can be safely recommended.

It should be added that the author makes no extravagant claims for the system of which he treats, nor does he think that it will supersede submarine cables for commercial purposes, but he recognises the great utility which it may afford within a modest sphere.

E. O. WALKER.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

Records in Printing and Other Works by Electric Power.

AMONGST the many and varied applications of electric power few trades have shown better results than the printing trade. The recent pamphlets issued on the subject by Messrs. J. H. Holmes and Company are of such exceptional interest that we take special notice of their work, as being of great import to the community at large.

We have before called attention to the merits and success of the Holmes-Clatworthy patented system in newspaper offices, but the phenomenal extension of the use of this apparatus is in itself evidence of the saving and advantages to the newspaper owner. There are now over 119 of these individual equipments at work and in hand for our great newspaper offices, and the published list includes the oldest, largest, and best papers in the country. We also notice that papers in Australia and South Africa have taken advantage of the benefits to be afforded by the use of this system.

Messrs. Holmes are nothing if not progressive, and their system above referred to has also improved and advanced with the necessities of the times. The general arrangement of the motors is, we believe, familiar to most of our readers, consisting of a main motor direct geared to the press shaft, and capable of being varied through a wide range of speed to suit the requirements of the paper produced, and of an auxiliary motor and gear, which is used for starting up from rest

FIG. 2. NEW MOTOR CONTROLLER FOR HOLMES-CLATWORTHY SYSTEM.

and providing all small movements and slow speeds. The power of the auxiliary motor, which is equivalent to about double that which the main motor would develop at the slow speed at which the auxiliary motor drives it, is transmitted through worm gear

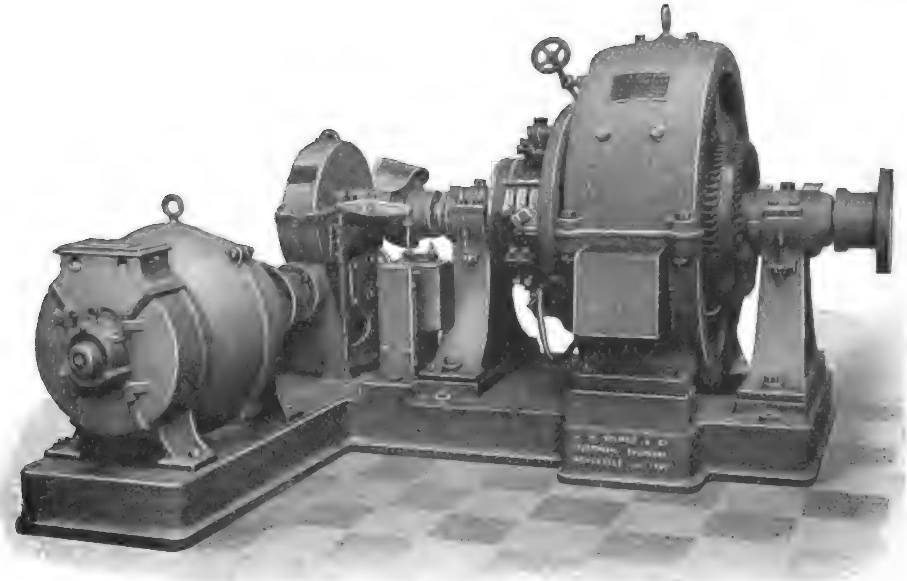


Fig. 1. Motor arranged on the Holmes-Clatworthy System.

and a claw clutch, electrically operated, and arranged so that when the main motor overruns the auxiliary one the clutch automatically disengages and the auxiliary motor comes to rest. Fig. 1 clearly shows the arrangement.

The latest development is a pilot system of control by which the whole system is regulated and controlled by a small push switch, one or more of which are situated at convenient places about the machine. Moving the push on one set of contacts starts and accelerates the motors to the desired speed, a second movement in another direction reduces the speed as desired, and if the pressure is continued gradually brings the motor to rest. Stop pushes are also provided by which the motors are caused to rapidly stop. The feature of being able to rapidly bring the motors to rest is very important, and this is attained by means of an automatic electrically operated brake. The rotating mass of twenty or thirty tons running at 200 revolutions per minute is brought to rest in a few seconds.

When the stop push is operated the main controller automatically and immediately assumes its initial or starting position, in readiness for a fresh start. This arrangement has been most satisfactorily at work in one of our largest London newspaper offices for some time past, and has been so much appreciated as to warrant the extension of the system to other machines.

Figs. 2, 3 and 4 show the latest form of the main controlier.

The latest pamphlet issued by this enterprising firm is framed in quite a novel manner, and we strongly advise our readers to procure for themselves a copy.

Messrs. Holmes and Co. claim to have had more experience in the equipment of newspaper offices and printing works with electric motors than any other firm of electrical engineers in the United Kingdom. Their list of installations, which has recently been brought up to date, proves this to be based on substantial grounds. The list contains the names of 239 newspapers, printers, and paper makers in whose offices they have installed dynamos and motors with an aggregate of 18,000 brake horse-power.

Messrs. Holmes are equally well known for the lighting and power transmission work they have carried out in heavy engineering works, shipyards, collieries, central stations, textile mills, &c. The lists they have recently published indicate their extensive experience. The resourcefulness exhibited at their works at Newcastle-on-Tyne in the arrangement of their power plant to secure the most economical conditions of working, one of the chief factors in successfully meeting the present severe competition, is a guarantee of the firm's capacity, and possibly that circumstance

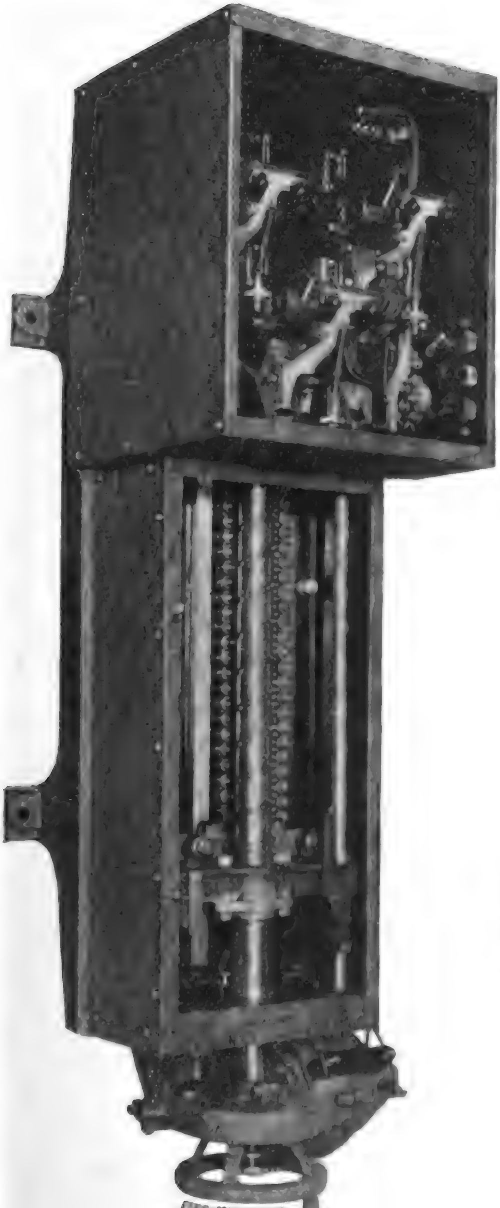


Fig. 3. New Motor-operated Controller complete.

alone points to some of the reasons for their phenomenal success.

It is not possible in a short article to deal at any length with their record of work done, but a brief summary provides an interesting list. They have manufactured the plant and installed electric light in nearly 1,000 steamships and yachts, amongst them being the royal yachts of Spain, Portugal, and Siam. In the principal collieries of Northumberland, Durham, Yorkshire, Lancashire, and Scotland they have fitted plant for hauling, pumping, coal cutting, and lighting. The names of the chief shipbuilding and engineering firms, railways, and dockyards appear in their lists. The work they have carried out in cotton, woollen, silk, and other textile mills would be sufficient in itself to satisfy the ambition of most firms, and the central supply station contracts they have carried through for Hackney, Aberdeen, Cleckheaton, Hull, Sunderland, Perth (W.A.), and many smaller concerns testify to their enterprise amongst municipal authorities. In the lighting also of mansions and country houses they have probably had as extensive experience as any firm in England.

The foregoing is a brief and very incomplete record, but we think it is sufficient to demonstrate that Messrs. J. H. Holmes and Co. justly stand amongst the first electrical plant manufacturers and contractors in the country.

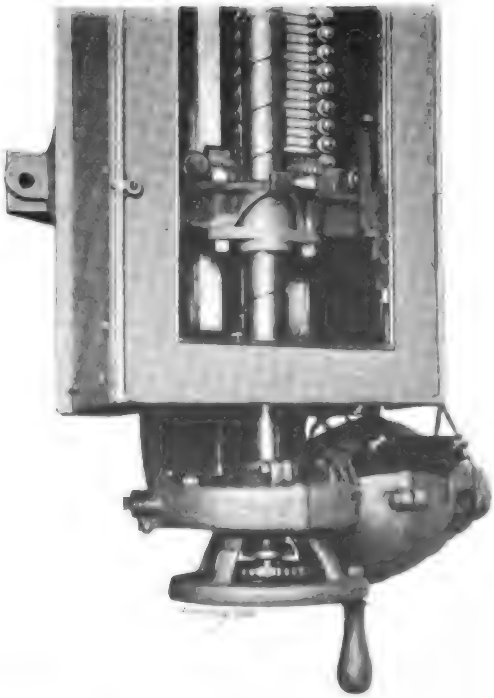


Fig. 4. Motor-operated Controller, showing nearer view of Motor and substantial construction of Contactor.

High Speed Engine Economies.

In last month's issue we gave some particulars and illustrations of high speed engines manufactured by Browett, Lindley and Co., Ltd., Patricroft, Manchester. It was there mentioned that the high speed engine has all the appearances of an exceedingly simple engine. This is a fact, but although when high speed engines were first manufactured they were very uneconomical, the high speed engine of to-day may be placed among the most economical engines of the world. Messrs. Browett, Lindley and Company have always been to the front in introducing improvements which they were sure would tend to the more economical working of their engine, and to-day it can certainly be said that they manufacture high speed engines of the highest class.

Higher steam pressures and superheat very considerably affect the economy of this type of engine, and as illustrating the effect of superheat on a triple expansion engine a curve is given in Fig. 1. In this diagram the pressure is taken at 150lb. per square inch and the steam consumption per kilowatt-hour corresponding to the various degrees of superheat can be measured by the vertical ordinates. It is surprising what low steam consumption can be obtained with an engine of 800 to 1,000h.p. of this type, and it can safely be said that the consumption is equal to that obtainable with any other class of engine.

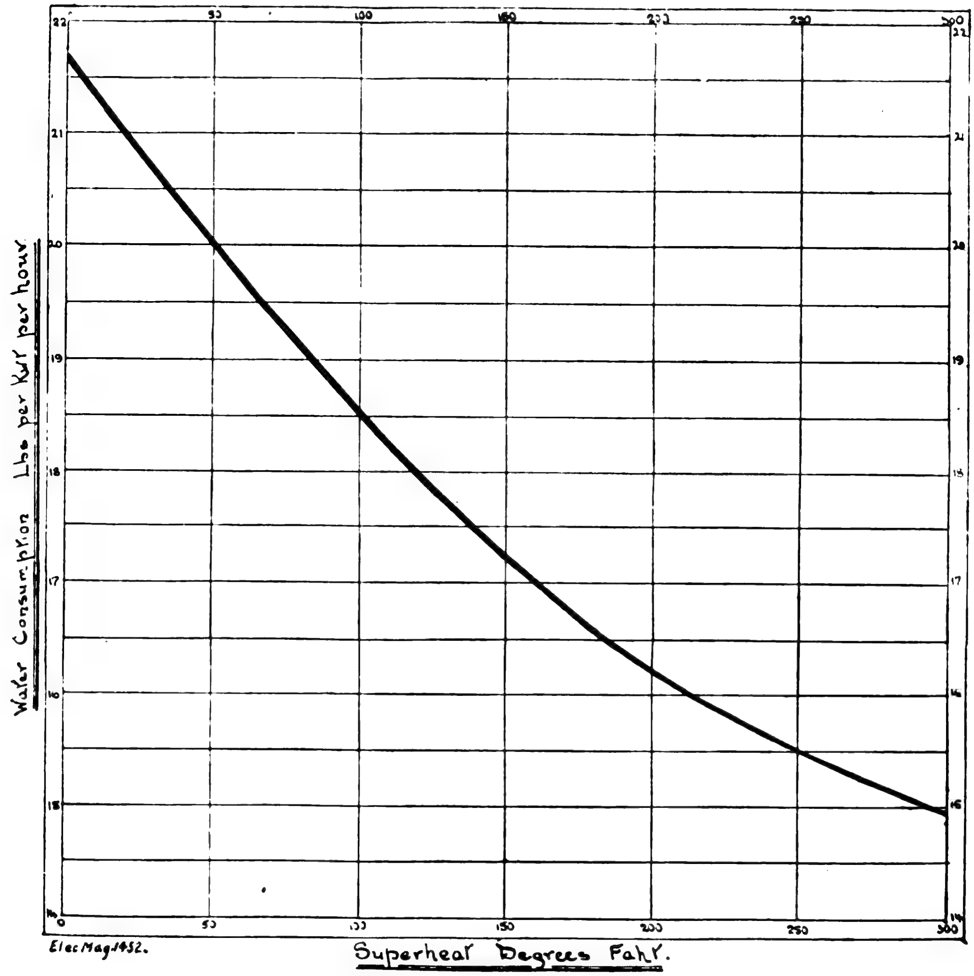


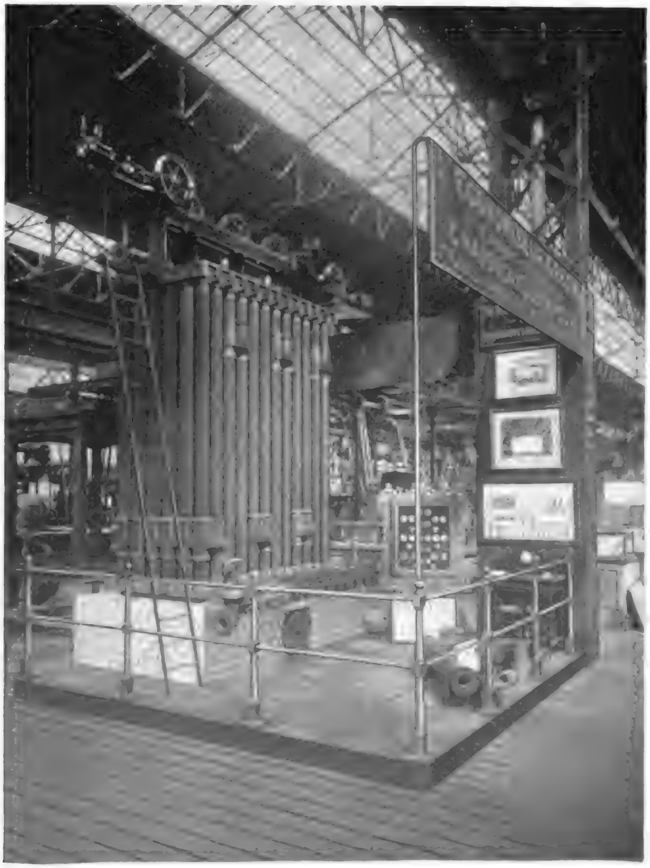
Fig. 1. Curve showing effect of Superheat with a Triple Expansion Engine.

It is a point worth noting that the advantages of a triple expansion engine of this class appear to be greater than those of the slow speed type, as with superheated steam almost equal economy can be obtained with a compound engine as with a triple. In all probability this is due to the increased clearances, &c., necessary for steam passages in high speed engines.

The steam consumption shown in the curve is given in lbs. per kilowatt-hour; this, of course, takes into consideration the mechanical efficiency of the engine and the efficiency of the generator. A very high efficiency can be obtained with this class of engine owing to the perfect system of lubrication adopted. In the early high speed double-acting engines, the ordinary gravity or splash system of lubrication was employed, but this was not thoroughly satisfactory, as owing to the number of revolutions and consequent reversals of pressure in the bearings there is not time for the oil to spread itself over the surface with the gravity system of lubrication. With forced lubrication the oil is supplied to all bearing surfaces under a pressure of from 20lb. to 30lb. per square inch, so that immediately the bearing is relieved owing to the reversal of pressure—which occurs twice per revolution—the oil is ready to immediately spread itself over the surfaces. Special mineral oils are used for the lubrication of the motion work of this class of engine, and is generally of a thin body, and a thick film of thin bodied oil accounts for the very high mechanical efficiencies obtainable with these engines. At the highest speeds the engine cannot be indicated with the same degree of accuracy as slow running engines, but very careful readings show that the mechanical efficiency of this type of engine averages about from 92 to 93 per cent.

Green's Economiser at Liège Exhibition.

The Machinery Hall at the Liège Exhibition is of considerable extent, and many fine exhibits of stationary engines, locomotives, machine tools, &c., are on view. The Belgian section, of course, predominates; in fact, the bulk of the space is allotted to it. The finest exhibit is by the well-known firm of Société Anonyme John Cockerill, and a notable exhibit of this firm is the three-cylinder horizontal gas engine, developing 10,000h.p. America and Germany are also well represented, but the British section is comparatively small, there being in all only seven firms who represent the engineering industry of this country. Prominent amongst these exhibits is that of the well-known Green's economiser, which fills a corner position, and though not occupying a large



Messrs. Green and Sons' Stand at Liège Exhibition.

amount of space is very neatly set out. It is scarcely necessary to go into details about this well-known apparatus, as it has been described so frequently during the past few years. Briefly stated, the economiser is one of Messrs. Green's recent high-pressure type, and contains 72 heating tubes, which represent a total heating surface of about 720sq.ft. The usual branch pipes and valves are fitted to this apparatus, and on the gearing frame at the top is attached an electric motor which operates the usual scraper attached, and shows the method ot keeping the exterior surface of the tubes free from soot. There is also a small horizontal steam engine attached to the gearing frame, which is in operation also to indicate that the scraper can by driven by steam where other means are not available. The brickwork setting is of white enamel brick, which gives a smart appearance to the exhibit. There were specimen castings of tubes and bottom boxes on the stand, and also one specimen of a vertical tube burst under pressure of about 3,000lb. pressure on the square inch. Messrs. Green and Son, Ltd., also displayed a large number of medals, diplomas and awards that have been gained for this famous apparatus.

A. E. G. Electric Pumps.

To meet the rapidly extending use of electric power for the driving of pumps, this company has designed an outfit in which a thoroughly modernised pump has been made in all respects suitable and adaptable, from the mechanical point of view, to the running conditions of high-speed electric motors. To attain this result it has been necessary to embody a design in which a very compact arrangement of pump and motor would be obtained. In working out the details of the pump great care has been exercised to obtain the highest possible degree of perfection in all points, and an electric pump has now been introduced which will not only fulfil the above conditions, but will also meet the fullest requirements as regards reliability in working, simplicity in construction, efficiency, and wide range of application.

Although the A. E. G. pump is essentially designed for high-speed electric motors, it can also be direct-coupled to slow-speed motors, and it may be further mentioned that, when electric power is not available, or is too costly, the pump can be direct-driven from oil, gas, or petroleum engines, or from countershafting by means of belt.

To meet the various conditions of delivery and head arising in practice, the pumps have been standardised in a large number of sizes, and, due to the large scale on which they are manufactured, pumps of different outputs are at all times kept in stock or are under construction, and therefore can be shipped at very short notice. The sizes and types are so grouped that deliveries from 22 gallons per minute up to 770 gallons per minute can be dealt with. The lifting heights range up to 560ft., including 26ft. suction, and the pumps can be used for every possible purpose; to name a few examples—water-works, boiler-feed, mines, irrigation, fire-pumps, &c.

The single-acting principle has been adopted throughout, and for the smaller outputs one plunger only is used, but in the larger sizes, where the necessity for dealing with greater quantities of water requires it, double plungers are employed. All parts are designed specially for the requirements of high-speed pumps, and a short stroke is chosen to keep the plunger speed within the required limits, namely, 3ft. to 4ft. per second.

To render the flow of water uniform from the delivery outlet, which is arranged on the side of the pump, an ample delivery air-vessel is provided. The valves open and shut automatically, and to make certain of proper working at the high speeds of the pump, they are specially designed for the purpose, with as little weight as possible, small lift and large valve area, so that all pounding or failure in action is obviated. The valve seatings and rings are of metal; to prevent leakage, the seatings are provided with leather rings, but, for pumping warm water, metal seatings are alone employed. The springs are of hard-drawn brass, and keep the valves firmly up against the seatings.

The stuffing-box, which is readily accessible for packing, is situated in the water space of the suction chamber, and is thereby thoroughly cooled, so that a special lubrication of the plunger is unnecessary. An air compressor is supplied to furnish the necessary compressed air to the delivery air-vessel, and is driven from the cross-head pin directly, or, in the larger types, by a pin from the end of the pump shaft (Fig. 1). The compressor cylinder is designed with a large clearance space; to compress the air to the pressure required to discharge into the air vessel,

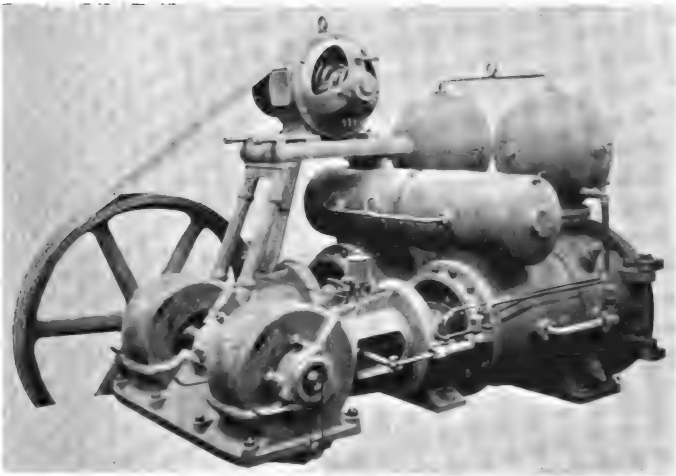


Fig. 1. View of complete A. E. G. Electric Pump for High Speeds.

the clearance space must be filled with water. For this purpose water enters the compressor at the end of the suction stroke, when the plunger uncovers several openings in communication with the air-vessel. The crankshaft, which is of best Siemens-Martin steel, is forged in one piece, and is accurately turned and polished all over. The main bearings are self-lubricating, being supplied with a large oil-well, with oil-rings running on the journal. At the outer ends of the bearings, two extra rings are forced on to the shaft, and throw the oil from the shaft back into the oil-well. The crank-pin is lubricated by means of a special ring on the crank-arm, and the oil is forced through conduits, by centrifugal action, on to the surface of the crank-pin. All bearing surfaces are amply dimensioned, in order to reduce wear to a minimum. The main bearings, and both ends of the connecting-rod, have fine adjustments to take up the wear when required. The design of lubrication, together with the very careful fitting together of the parts at the works, ensures a thoroughly reliable service from the pumps, even under the most exacting and prolonged conditions of working.

For driving the pumps by means of high-speed electric motors, belts are the most satisfactory, and years of experience by the company with all classes of pumps have shown this to be the case, and that no slip of the belt occurs in practice. Best leather belts are employed, and for damp situations special belts are used. The double reduction heretofore generally required for electrically-driven pumps with spur or worm gear cannot compare in efficiency with the belt drive, and, in addition to the unavoidable noise, gearing of the former description often leads to long interruptions due to the breaking of teeth. The steadiness of the drive is assured by the heavy fly-wheel, and in the standard types the fly-wheel itself is driven from the motor-pulley. The ratio of speed variation in the different types varies between 1/70 and 1/30, and these limits also fully answer the requirements for uniform energy consumption from the electric supply mains.

The energy consumption of the pumps, based on the watts consumed per actual quantity of water lifted to a given height, is extremely low, and the combined mechanical and volumetric efficiency varies, according to the capacity of the pump, from 70 per cent. to 80 per cent., including the losses in the belt. The consumption of energy of an electrically-driven pump can be easily determined, whereas, with steam drive, this is frequently impossible.

A pump of this design, running with a great number of strokes per minute, in comparison with a slow-running pump with long stroke, divides up the quantity of water to be delivered, in a unit of time, into a correspondingly increased number of smaller deliveries. These, following each other in rapid succession, constitute more nearly a continuous delivery than that obtained from a slow-running pump, even if multiple-acting.

New Catalogues.

Condensing Plants. — THE MIRRLEES, WATSON CO., LTD., Scotland Street, Glasgow. A very handsome pamphlet has just been handed to us by the Mirrlees Watson Company, in which their condensing plant specialities are appropriately described and portrayed. The typography and illustrations are everything that could be desired, in fact, the latter are quite models of clearness. In addition to describing and illustrating typical installations of the company's apparatus, the brochure contains a tabulated list of installations supplied for both reciprocating engines and steam turbines. We make special reference to the company's specialities in our Supplement this month, and refer our readers to this for additional particulars, though recommending them at the same time to apply direct to the company for the pamphlet to which we refer.

Steam Pumps.—HOLDEN AND BROOKE, LTD., Sirius Works, West Broughton, Manchester. List No. 82 describes and prices Brooke's patent "Expulsor" steam pump. This is a cheap and handy device for builders and contractors, underground pumping and for sinking and drain operations.

Transmission Plant. — BROWN, BOVERI AND COMPANY, Baden, Paris, and Milan. Continental electrical manufacturers believe in publicity, and are past-masters in the art of securing it. Expenses incurred in the production and distribution of literature are regarded as essential to the conduct of business, at any rate, this would seem to be the case with Brown, Boveri and Company. This company recently forwarded to us a high-class production describing and illustrating the Gromo-Nembro 40,000 volt three-phase power transmission scheme installed by them in Lombardy. The chief feature of this is the switch-gear, which was specially designed for the high voltage. Contrary to general practice, mechanically operated E.H.T. switches were installed; the entire scheme is a magnificent example of extra high-pressure work.

Relays.—BROWN, BOVERI AND COMPANY., Baden, Paris, and Milan. Particulars were recently to hand of the overload and reverse current relays manufactured by this company. The time unit device, comprising wattmeter movement with weight and cord, are now very well known and extensively used. The pamphlet describing these devices is very well got up, is printed in English, and gives full details of the apparatus.

Electric Winding Engines. — SIEMENS BROTHERS AND CO., LTD., York Mansion, Westminster, S.W. The increased interest in electric winding plant for mining purposes adds considerably to the importance of the pamphlet on the subject just issued by Messrs. Siemens Brothers. It deals exclusively with the Siemens Ilgner system, and depicts from actual photographs a number of important installations by Messrs. Siemens and Halske on the Continent. Full details of the plant with diagrams of connections and performance curves are included, together with comparative figures of cost of both the electric and steam systems.

Motor Combinations.—DE DION BOUTON, LTD., Great Marlborough Street, Regent Street, W. The use of the petrol motor for driving small dynamos is on the increase, and as a result of an extensive demand a special line of dynamo-motor combination sets has been standardised by the De Dion Company. It is unnecessary to speak of the De Dion engine; it has already made a reputation for itself, and attached to a dynamo of a small output its field of utility is likely to become very much extended. A booklet has recently been issued giving full particulars of these sets, together with prices and instructions for the care of the motor.

Electric Control for Steam Steering Gear. —SIEMEN BROTHERS AND CO., LTD., York Mansion, Westminster, S.W. Circular Y.M. 108 describes the electric controlling gear for application to the steam steering of vessels. A full description of this was given in our last issue.

D.C. Motors and Generators.—BRITISH THOMSON-HOUSTON CO., LTD., Rugby. In pamphlet 181 type D.A. motors and generators are described in detail, particulars are given of the construction and winding of these machines, together with their ratings and speeds. Details of field rheostats for generators are also given.

Producer Gas.—MASON'S GAS POWER CO., LTD. It is frequently our privilege to receive and notice elaborately-prepared catalogues, but we have seldom seen anything to equal the handsome publication on Producer Gas for engines and furnaces just issued by this company. It goes fully into descriptive details of the works of the company and their chief products, and contains a section in which the latest forms of gas engines are depicted by beautiful illustrations. Its concluding pages give valuable and exclusive data on suction gas plants, and should be in the hands of every central station engineer. The booklet is replete with information, and is bound in a strong cover with a handsome design on the front page.

The Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

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The World's Electric Progress.

"The Electrical Magazine" and the Olympia Exhibition. ON September 25th there will be opened at Olympia, London, the first Exhibition of electrical plant, machinery, and accessories ever held in this country, organised not for private gain, but in the broad interests of the electrical industry. It has been promoted under the auspices of the Institution of Electrical Engineers and the National Electrical Manufacturers' Association, thus combining the professional and business elements, and assuring for it that recognition which it will most certainly have. Its president is Sir William Preece, its vice-presidents are men in the front rank of scientific attainment, and its executive committee is drawn from prominent men of our leading firms and big supply corporations. The combination is a notable one, and ensures for it wide recognition. It is stamped with the hall mark of success at the start, and the ready way in which space has been booked in the huge building at Olympia guarantees that no such gathering has ever yet assembled under one roof. This Exhibition comes at the right moment. Electrification is in the air, and nothing could conduce more to the advancement of the industry, which is spelling progress in every direction, than the great Show which will surely attract people of all classes and all trades to its doors. The opening of the Exhibition is an event of prime importance to British electrical manufacturers. Another event of equal importance, running concurrently, will be the production of a great Exhibition issue by THE ELECTRICAL MAGAZINE. This work is in active preparation, and it is safe to say from the way things are shaping that it will not only be a unique Souvenir of the Exhibition, but the finest number of any electrical periodical ever issued. Readers will remember our St. Louis number. The Olympia number will eclipse it both in point of size, practical value of its contents, and commercial utility. We are already assured of the co-operation of many of the principal exhibitors. To those who have not yet come forward we simply suggest that their best interests will be served by the earliest possible communication with our offices. Our advice is—Don't proceed by half measures. If a thing is worth doing, it is worth doing *well*. To those who have signified their intention of being represented in this great issue we say, on this occasion, "Be whole-hoggers," and let us *worthily* represent you. We guarantee a twenty thousand circulation in October, the biggest thing ever done by an electrical journal. Finally, our September number, which will "boom" the Exhibition issue, should not be overlooked as a business producing number. We shall use it for our own purposes. Obviously it will pay manufacturers to use it for theirs. At our stand in the Exhibition we shall offer our supporters every facility and place our Intelligence Department entirely at their disposal.

The Municipal Antidote. ACCORDING to our American contemporaries a wave of enthusiasm, tersely termed a fad, for municipalising

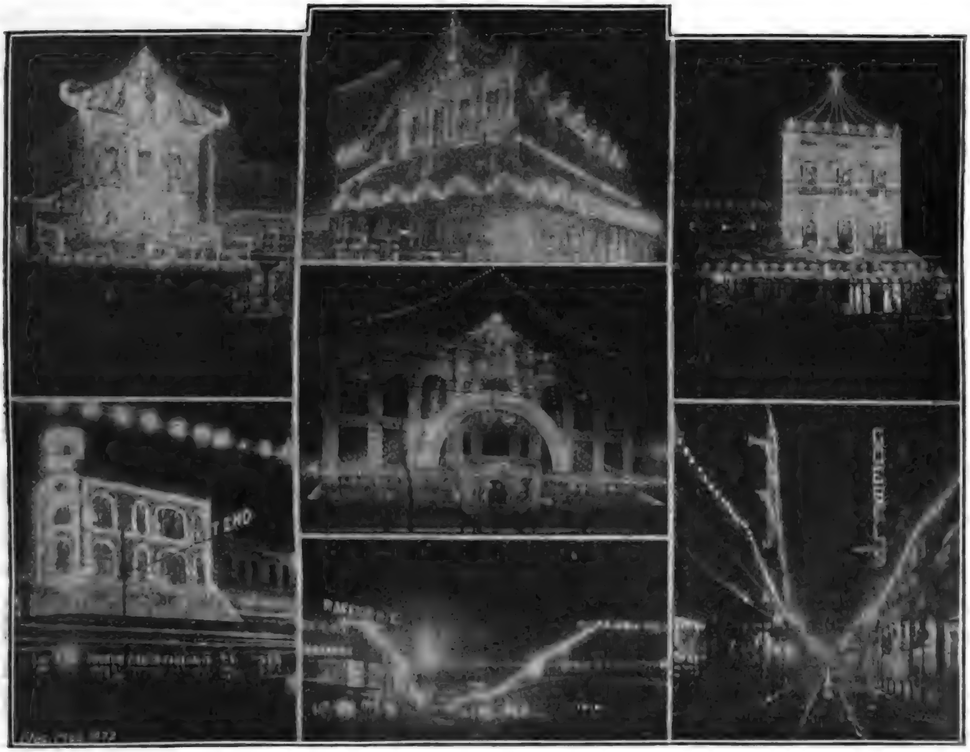
everything is sweeping the United States. Chicago has suffered many months with a particularly chronic form of "municipal madness," taking the shape of an overwhelming desire to bring the tramways under the civic sway. Railroads—that is to say, the tramways—in the packing city are in a shockingly decrepit state, and the citizens have to endure the evils of an indifferent service in addition to those inflicted by badly paved streets and tramlines in an even worse condition. While insignificant towns and districts rejoice in the possession of a liberal service with modern trolley cars, Chicago curses its creeping cable cars, and implores the body municipal to sweep the streets clean of these antediluvian substitutes for rapid transit methods. A feverish haste to take over the city tracks at once seized the inhabitants and spread to civic haunts, where it came to a head in a great hurry. In April last the mayoral election was fought and won on a tramways platform, and glowing visions were then seen of the immediate transfer of the tramway concerns to the hands of the city fathers. These occult dreams are yet unrealised, and Chicago still labours under the indignities heaped upon it by its much-maligned street traffic concerns. The latter, it seems, have also their grievances. They claim franchises extending over fifty years, and yet will not relinquish these in a hurry, despite the repeated denials of their rights by the city. In its despair, Glasgow has been made a *confidante* of its troubles, and Chicago has entertained Mr. James Dalrymple for a while to investigate the whole thing. This astute Scotchman is about the best tramway "medicine" man to diagnose Chicago's case, and although at the time of writing neither his prescription nor dose is made known to us, we expect a strong black draught will prove sufficiently corrective to ensure a complete and immediate recovery from the complaint. Mr. Dalrymple has been interviewed by the *Tramway and Railway World* since his return, and although he has not divulged the composition of his antidote to the municipal poison running in Chicago's veins, he draws some sharp comparisons between British and American tramway practice which leave little doubt in the mind that what is sauce for the goose is not sauce for the gander. He cites differences of franchises, fares, cars, and rails, and though persuaded that the municipal idea must grow and find favour ultimately, says in effect that the time is not yet for Americans to accept it on the European, especially the British, model. Meantime we must await the publication of Mr. Dalrymple's recommendations to the Chicagoans as handed by him to their representative in the person of Mayor Dunne.

Telephone Questions.

THE respective positions of Great Britain and the United States in matters telephonic might well engage the mind of some modern seer. There might be glimpses of the ultimate outcome of affairs vouchsafed to the prophetic vision when turned across the water as the contest between competing parties there is purely one of rates, and does not probably involve the condition of installations or the systems employed. Telephone traffic has, under the stress of competition, become elevated above the regions of experiment, and ranks as a public necessity which cannot be tampered with. American telephones have indeed reached the level of institutions, and as such are respected by those who run them for the public good. In a word American telephone systems have been made worthy the name, and notwithstanding the keen rivalry of competing interests, the subscriber gets the best possible service. When the eye of the soothsayer is turned on British telephony he will look twice at his telescope to make sure the right end is applied to his optic. He may also be compelled to remove the eyepiece to assure himself of its complete freedom from dust and moisture, for almost absolute fog will meet his anxious, straining gaze. At first sight he might say that British telephone affairs were shrouded in mystery as far as their future was concerned. The recent decision of the Home Government to buy up the National Telephone Company in 1911 and to issue no more licences to local authorities leaves us in comparative darkness as to what the years succeeding that date may hold for the thousands of patient telephone users in the United Kingdom.

The Mardi Gras.

RELIGIOUS institutions in this country seldom mark their feast days by public demonstration. We are too phlegmatic a



SPECIMENS OF DECORATIVE ELECTRIC LIGHTING AT THE MARDI GRAS CELEBRATIONS, NEW ORLEANS.

nation to go into ecstasies over the termination of Lent or the ending of the period preceding it. Not even Christmas, Easter, or Whitsuntide stimulate us to further rejoicing than gastronomic indulgence behind the walls of our dimly lighted houses. The world is given no hint that we are *en fête*. In New Orleans they do things differently. The religious feelings of the populace cannot find full expression unless the whole town gives itself up to rejoicing. Festivities do not cease at sundown either, and under cover of darkness electricity gives abundant evidence of its powers in starry signs, flashing searchlights, and glittering streamers, strung from roof to pavement, from tree to tree. Mardi Gras, or Fat Tuesday, in New Orleans is a day of feasting, frivolity, and excitement, and its closing hours have recently become the most brilliant portion of a most exhilarating twenty-four. Some idea of the wealth and extent of the illuminations this year can be gathered from the adjoining series of views, which, by the way, are reproduced from our esteemed contemporary, the *Western Electrician*. The citizens were loyally supported in their jovial intentions to continue the gaieties after dark by the local tramway company, who supplied current to some 25,000 lamps of many sizes, shapes, and colours, which bedecked the halls, shops, and mansions of the city. This number of lights, we are assured, was especially erected for the occasion, and does not include the extensive display of signs and shop decorations which normally illumines the chief thoroughfares. The supply company were enterprising enough to put their many effects on record and a series of excellent illustrations resulted to mark what was a record in the way of illuminations of Mardi Gras hilarities.

London's Traffic.

IN our "Traction" section this month will be found an abridged account of the report of the Royal Commission, whose recommendations for the solution of a difficult problem have been criticised more

or less favourably in the technical and lay Press. In some quarters the opinion has been expressed that even if apparently adequate transit facilities are afforded congestion will still hamper speedy transport, and a similar dilemma will confront the highway authorities. When the arguments for and against such a view are sifted, the balance of opinion seems to us to favour it distinctly. The question resolves itself into one of supply and demand, and it can reasonably be assumed that with augmented facilities for the greater flow of traffic, the density of the avenues of transport would proportionately increase. In an astonishingly short space of time, methods of locomotion have been improved almost to the limits imposed by the design of the vehicles in question, while the means of reproducing each particular type have correspondingly grown. Obviously the provision of broader, longer, and better highways within a city's boundaries must stimulate the demand for the improved forms of vehicles, and upon this process of expansion there seems to be no let or hindrance. While heartily approving of the many excellent suggestions of the Commission, several of which should be put in practice without delay, we feel that our approbation of a long and strenuously prosecuted enquiry must be qualified by a want of confidence in any panacea prescribed for what is really a cumulative complaint in crowded cities or towns.

Is Niagara Doomed?

Our American friends have become really concerned about Niagara, or rather about what is transpiring around it. Such large drafts of water are being now made, and even larger are still to be made, on the water destined by Nature to tumble in majestic masses over the lip of the Falls, that were further extensive concessions given to power concerns the Falls proper would quickly disappear. It is not difficult to conjure up in the mind a picture of the imposing rock traversed by a few trickling streams, while lines of power houses in greedy array engulf the diverted waters earning the tourist's curse and the citizen's blessing in their constant endeavour to become useful. At the present moment, from such figures as we have at disposal, something like 266,000h.p. is being utilised for all purposes at the Falls, and the developments in hand provide for nearly double this

Ontario Power Head Works. Electrical Development Company. Canadian Power Company. Ontario Power Company.

Bird's Eye View of Power Developments around Niagara Falls.

View of Canadian Fall, Niagara, with Ontario Power Company's Station on right under the Cliff.

of water per second under a head of 175ft. The water supply system differs from all the other plants at the Falls in that the forebay is situated above the Falls, and furnishes water to a series of steel pipe lines which conduct it to the station erected below and facing the Falls proper. The generating plant is also kept entirely separate from the controlling, transforming, and distributing apparatus, this latter being housed in a separate building high above the power house, on the cliff. The entire plant has many unique features, and any of our European readers who are visiting the States this "fall" should take an opportunity of inspecting it. At the same time they will be able to admire those wondrous beauties of the Falls which, though threatened with extinction by their too zealous electrical brethren, are yet displayed in all their grandeur, as we doubt not they will be for many a year to come.

amount of power being drawn off in the very near future. Particulars are given in the "Power" Section this month of the enormous station of the Ontario Power Company, a concern whose works were quite in the skeleton state when the site was visited on the American tour last year. Work has been pushed forward to the extent of getting one of the 12,000h.p. units running, while the other sets are being erected as rapidly as possible. Through the courtesy of *Canadian Machinery* we are able to present our readers with a bird's-eye view of the developments around the Falls, and also one of the main generators being wound in position. Our other view of the Falls and the Ontario Company's power house is taken from the *Western Electrician.* The turbines are the largest of the horizontal type yet constructed, and have been built in Germany. They stand 13ft. high, and measure 21ft. by 29ft., and are rated to give 11,390h.p. with 700 cubic ft.

Winding the Armature of a 10,000kw. Alternator in the Ontario Power Company's Power House, Niagara Falls.

Gas to the Rescue of Water Power.

Electrical engineering, especially the heavier branches of it, is full of anomalies. These frequently take the shape of extraordinary plant combinations, belt-driven generators being mixed up with turbine sets, with dashes of rotary converters and dots of arc lighters probably thrown in. From the far west of the United States now comes news of the operation in double harness of a 140-mile transmission line fed by numerous hydro-electric plants, and an oil-gas engine station! It appears the California Gas and Electric Company cast envious eyes on the United Railroads or, as we should call them, tramways of San Francisco, and deemed it expedient that they should furnish these with electric power from their water plants high up in the mountains. The tramways company, however, had heard fame of breakdowns and interruptions which at times denuded San Francisco of its benison of light and power, and consequently before closing with these universal providers of electrical energy asked for some stand-by guarantee should supply at any time be suspended. At present the tramways are run by steam plants, and these were suggested as a suitable reserve by the water-power company. Naturally this did not suit the tramway managers, as steam could not always be kept up, and, even with banked boilers, a tantalising delay must ensue before long lines of waiting cars could be got away from their enforced halting places. Rather than lose this precious contract the California Gas and Electric Company decided to instal at the distributing end of the transmission lines a large gas engine station, which will create other records beside that of being the first plant of the kind to act as stand-by to a water-power plant. Certainly there could be no more ideal form of reserve than a gas plant, and the company has made a wise selection in deciding upon its adoption. In the matter of size the units installed will eclipse all existing patterns, the capacity decided upon for each set being 4,000kw. Mr. J. Martin, in a paper recently presented to the Pacific Coast Gas Association, gave a preliminary outline of the design adopted for the engines. They are to be of the horizontal twin tandem, double acting, four cycle type, giving two impulses to each crank revolution. The working parts in their entirety are to be above the engine room floor, and spacious culverts are being arranged to accommodate the various piping systems. A special study has been made of the lubrication and this is arranged on a pressure system, oil commencing to flow as soon as the engine starts. The valves, mixers, and small internal moving parts subjected to the heat of the explosive gases are so placed that they can be cleaned with a gasoline spray without removing heavy parts. The dimensions and weights make instructive reading: length over all, 70ft.; width, 34ft.; heaviest casting weighs 60 tons; cylinder diameter, 42in.; stroke, 60in.; shaft diameter at centre, 38in; flywheel weight, 58 tons; total weight of engine, flywheel, and generator, 535 tons. It is hoped that the installation will be in operation on or before January 1st next year, while, with equal confidence in the time of completion, the engineers anticipate startling results from the operation of this decidedly unique stand-by plant.

Mercury Converters for Traction.

Whatever the advocates of polyphase traction may have to say in support of their claims to general recognition, they have to face one of the hardest things encountered in developments of any kind—prejudice. That prejudice is against the overhead wire and a practically duplicated system of connections. High efficiency, flexibility, regeneration, and what not are well enough in their way, but in railway working simplicity has got to come first. It is just here that the one phase system receives first consideration, and it will continue to take precedence over polyphase work on that ground alone. But though one phase generation and transmission are so simple, matters get more complicated on the other side of the transforming outfit. The one phase commutator motor is really a very bad form of direct current motor, and but for the economies of the high voltage transmission would have nothing to commend it over the direct current machine. An obvious compromise suggests itself in a combination of one phase currents and direct currents, the former to be generated and transmitted to the trains, and the latter utilised for the motor service on them. In this field the mercury vapour rectifier or converter promises interesting developments, and a successful outcome of these would result in what has every appearance of a happy association of two systems, themselves

separately inadequate. Both the mercury converter and direct current motor would materially lighten the car equipment, while the combined efficiency of the system would be considerably enhanced. Further research in this field will doubtless overcome the crop of difficulties intervening between the present state of the mercury converter and that ensuring its successful use for railway work.

William Edward Langdon.

SLOWLY but remorselessly the hand of death is widening the gap between the new school of electrical engineering and that of the pioneers who steered the industry through troublous times. In the passing of Mr. W. E. Langdon another link in the chain is sundered between the present and the past. The majority of our readers will recall the tall figure of Mr. Langdon at the Institution meetings, especially during the session 1901-2, when he occupied the presidential chair. He has been intimately connected with the electrical departments of two of our great railways, and though primarily associated with their telegraphic aspect he was instrumental, in the case of the Midland Railway, in designing and erecting nearly a dozen stations for electric lighting. These plants formed a standard for such work, and have been followed closely by other systems when installing electric lighting for stations and yards, information and data being readily accessible through the magnanimity of Mr. Langdon. His ability and capacity for organisation met with early recognition, for in 1872 he was a member of the Institution, then the Society of Telegraph Engineers, and acted, on emergency, as its secretary in 1877. In 1898 he was elected to the Council and subsequently became president, as we have already indicated. Many and varied contributions to the "Proceedings" were made by him, and great interest was taken in his views on main line electrification enunciated at a time when the problem was only lightly regarded by electrical men generally. In expressing our deep regret at the death of Mr. Langdon we feel that we voice the sentiments of our many readers, among whom those more intimately associated with him will mourn his loss. Mr. Langdon was 73 at the time of his death.

THE WINDMILL.—VI.

Operated by DON QUIXOTE.

The Transports of London.

WE are an awful nuisance to ourselves. If we take life at all seriously (and parsons tell us that Man is born to achieve some high and useful purpose) we are immediately impressed by its inefficiency. We are seized with an Idea which will enable us to achieve the aforesaid high and useful purpose. Very well: we have first to overcome that mental inertia which precludes sudden effort of any kind. Then we waste valuable time in combating the viscous condition of what is known as "public thought" (which is really public thoughtlessness) in order to save ourselves from becoming positively outside the pale, owing to the operation of our Idea. The preliminaries settled, we put the machinery of our physical forces in motion, and by the time we have accomplished a railway journey or two, duly stoked ourselves at an A.B.C. restaurant, and restored our grey matter to its normal condition by a four-and-sixpenny bed-and-breakfast at a metropolitan hotel, we are impressed with the awful internal friction occasioned by our too too solid flesh, which reduces the efficiency of our ideal life to something in the neighbourhood of nought five per cent.

The above is not the beginning of my next Sunday sermon, but the result of reading the Report of the Royal Commission appointed to inquire into and report upon the Means of Locomotion and Transport in London. By a fatuous impulse of imitation, born of the aforesaid public thoughtlessness, we crowd ourselves together in little pens of offices in the most restricted area possible, and call the aggregation the First City of the World. Having then got ourselves into close juxtaposition with everybody else, and finding it inconvenient to be continually prodded with alien umbrellas, we raise a piteous wail that we can't get about as we want to. The King thereupon issues greetings to a few of his right trusty and right well beloved cousins, and to a few others who are only "trusty and well beloved" without being "right," and tells them to find out how to get us out of the muddle. And having examined quite a lot of people, and worried the bone of contention for two or three years, the sorrowful conclusion is arrived at by the cousins and the unrighteous that the chief difficulty in the way of doing anything is the lack of

sufficient cash to do it with. And that this is a safe conclusion I know from my own experience: I have felt that way many a time.

The whole thing, however, is very funny. For roughly five hundred years public thoughtlessness has caused first a dribble, then a stream, then a flood of people from every place under the sun to rush to London. What for? Is the ratio between wage-earning and living expense higher in London than elsewhere? Why do nine young men out of ten desert their native village to lose individuality and most other things worth having in the black tide that swirls along the narrow canyons known as the streets of London? If one man in a thousand walks on the heads of his fellows, then nine hundred and ninety-nine must bear the marks of his hobnails on their craniums.

And the humour of it all is this, that having for five hundred years pursued an evil course that has brought on an acute attack of congestion, the population of London suddenly bethinks itself that perhaps the Sages will tell it how to be indiscreet without being incommoded, and how to do it cheaply. As well for a man who has ruined his stomach by high living to try to put matters straight with a penny box of pills! As the sage hath it, gastronomy and economy cannot go together.

Of course the Sages have done their best with the problem, but their labour has been like unto the cleansing of the Augean stables. There is a tone of mild hopelessness, as of brave men fighting against odds, running throughout the report. "The man in the street, what to do with him? Heaven only knows!" That is the gist of the whole thing.

And seeing that they cannot do much with the man, the commissioners have rounded on the horse. The following extract shows their trend of thought towards that faithful friend of man :—"Cabstands in crowded streets are an obvious impediment to the traffic; but so long as cabs are used there must be cabstands." A spirit of hostile criticism that augurs ill for the horse. Take again the "Recommendations as to Tramways." Herein is written, "At present the horse omnibus provides a means of transit for short distances, but we do not think it would compete with an efficient system of tramways: it has never done so in London or elsewhere. Where there is fair competition the same thing will happen in London as happened in Liverpool between the years 1897 and 1903: within a period of seven years all the omnibuses disappeared from the streets, and gave place to electric tramcars." As electric men we should rejoice, but is it fair on the horse! Even as to the motor omnibus, with its huge smell, it is said that "Unless the cost of running and maintaining these vehicles largely exceeds the expectations of those engaging in the enterprise of providing motor omnibuses, they will practically supersede horse omnibuses, and thus remove from the streets, greatly to the public advantage, a form of service which, although it has been of great public utility, is now one of the principal causes of congestion in many streets." There you are again; no compassion for the trusty, worn-out servant! There is no room in London for both man and beast, so that unless we get a Far Eastern question surpassing the Russo-Japanese shambles the horse must go.

And now we hark back to that Idea that was to serve a high and useful purpose. It is very simple, yet owing to the hopelessly gregarious instinct of men that compels them to huddle together in large masses, I believe it will never be adopted. The solution of the traffic problem of London lies not in viaducts nor shallow subways, in trains and trams. It lies in a changed mode of life. Why should we hustle and jostle to get to the centre of the London whirlpool? There is livelihood and a happy mind to be found in the green country side, where there is room to draw a big breath of free air. For me, if anybody would give me a big enough start, I would get away out to the banks of the Victoria Nyanza, and sit under my own vine and fig-tree.

Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Niagara Power Developments.

FEARS are being entertained that Niagara will shortly be reduced to a dry rugged escarpment, bereft of beauty and sacrificed to the needs of a mercenary and utilitarian age. Time alone can prove whether the great cataract will yield its mighty energies into the hands of man and thereby lose its charm for the impecunious and dissatisfied tourist. Interest at present attaches to great developments in progress there for the utilisation of the waters of the falls for power transmission purposes. Mr. P. N. Nunn recently gave details of some of these before the American Institute, and we quote his remarks *in extenso :*

"Standing upon the upper steel arch bridge and facing the Canadian Falls, one may observe at the foot of the cliff forming the right-hand wall of the gorge a long but unobtrusive building, its farther end obscured by spray from the great cataract. It is of modest though massive design, and its colours also blend with those of the overhanging cliff. This is the power house or generating station of the Ontario Power Company. To the right, high above and behind the power house, upon the bluff overlooking both gorge and cataract, may be seen another great structure, less massive but more ornate, which, on account of its commanding position, is by far the most prominent landmark of the Canadian side. This is the distributing station of the same company, from which the power generated below is controlled, measured, and transmitted. Away to the left, around the bend of the river and hidden by the trees of Goat Island, lie the walls, abutments and buildings of the intake and head gates through which the water from Niagara River is diverted for use below. In the park between these extremes, seen just beyond Horse Shoe Falls, stands the power house of the Canadian Niagara Power Company, while to the left another power plant, that of the Electrical Development Company, is rapidly building. Fig. 1 is a map showing the location of this plant and also the other power developments about the falls.

"The intake works for the entire 200,000 horse-power are now finished. One of the three main conduits is completed, while for the second and third portals and head-gates have been installed and a portion of the excavation made. Six of the twenty-two penstocks are already in place within their shafts and tunnels and two others are building, while the power house is nearly prepared for the concomitant apparatus. The distributing station is ready for the switchboard of the entire twenty-two units, for the transformers of eight, and for the apparatus of fourteen.

"The intake works have been located and designed with especial reference to the ice difficulties which have been the limiting factor in the success of Niagara power. Cake-ice in enormous quantities floats down for weeks at a time from the great lakes, and mush-ice is formed in the turbulent rapids primarily by the freezing of spray and foam and secondarily by the disintegration of cake-ice. To avoid the latter the intake is located in the smooth but swift water just above the

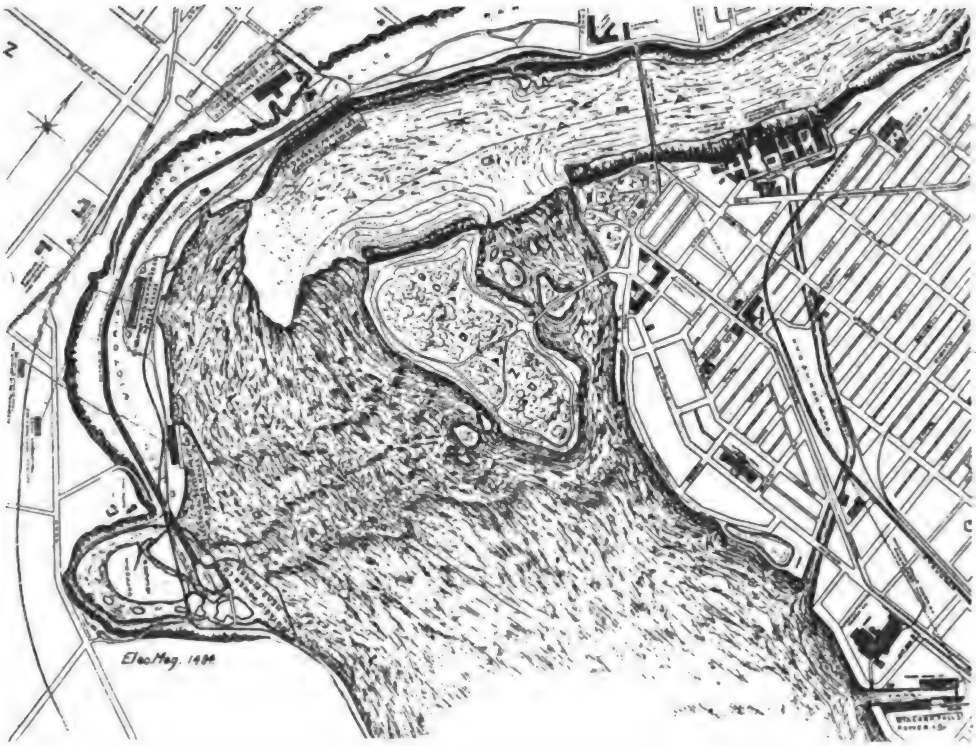


FIG. 1.—PLAN OF NIAGARA FALLS, SHOWING THE GREAT POWER SCHEMES, BOTH IN OPERATION AND CONSTRUCTION.

rapids; to exclude the former the following features have been introduced:—A long and tapering forebay, protected at its entrance by the main intake, terminates at its narrow down stream end in a deep spillway. Upon the river side it is enclosed by a submerged wall, while the other side adjacent to the spillway is occupied by the main screen structure leading to the inner bay and to the portals and head gates of the three conduits.

"The water before entering the conduits must pass in succession three automatically-selective steps, each excluding surface water and its floating ice, and two screens, each behind ice-runs in heated buildings containing live steam for emergencies. Serious trouble is not believed possible while these provisions are maintained with reasonable care.

"The main conduits are of 0.5in. riveted and reinforced steel embedded in concrete, 18ft. and 20ft. in diameter, 6,500ft. long, and are buried within the rock and soil of the public park. Through them the water flows at a velocity of approximately 15ft. per second. Just beneath the top of the cliff behind the power house, within a long underground chamber, the arched roof of which supports the conduit above, 9ft. diameter branches pass from the under side of the conduit through gate-valves, and become the penstocks, each supplying water at 10ft per second to a single turbine. Each penstock has two expansion joints, a massive thrust anchorage in the power house foundations, and an automatic relief valve and stone catch discharging into the river. The 9ft. valves are electrically operated under distant control from the power house below, and are so constructed that all working parts may be removed for attention while the penstocks are in service.

"The spillway at the end of the conduit, to prevent water hammer in case of sudden loss of load, is a little more than the enlarged and elevated end of the main conduit equipped with an enclosed weir and underground discharge. Its peculiar features are its adjustable weir and helical discharge tunnel, which, after a steep initial pitch in the taper from the weir, follows a uniform grade and symmetrical curve while circling about to reach the

river, thus preserving a smooth unbroken water column of highest velocity and least expenditure of energy. The purpose here is to prevent erosion, restricted flow, and excessive air-suction, the latter on account of the danger of formation of ice from spray under forced circulation of air.

"The generators are of conventional horizontal-shaft type, three-phase, 25 cycle, and deliver 12,000 volts at 187.5 revolutions per minute. The turbines are of Francis or inward-flow type, double, central-discharge or balanced twin turbines designed to deliver 12,000h.p. under a 175ft. head. Their shafts are 24in. maximum diameter, and each carries two 78in. cast-steel runners of "normal" reaction. Fig. 2 shows a section through the generating station.

"Of the 175ft. head 20ft. is in the 10ft. diameter draught tubes, because the floor of the power house has been elevated 26ft. above mean water level to provide for the excessive variations to which the water in the gorge is subject. While the bearings are self-oiling, all are equipped with a water-cooling system, and for still greater insurance a piping system for the changing of oil has been so connected that in emergency it is instantly available for forced lubrication.

"Although entirely feasible to use the vertical-shaft turbine, and although restricted space at the power house requires greatest floor economy, nevertheless, horizontal units are employed on account of their freedom from step bearings, their higher efficiency, and their greater accessibility.

"Unit values corresponding to the generators in capacity and position are maintained throughout. Thus each generating unit has its individual cables, switches and switchboard section of bus bars, transformers, interrupters, and high-pressure switches complete to the transmission, enabling its independent operation as an isolated power plant, or through the selector switches and duplicate sectional bus bars, the operation of all units in any combination of groups as readily and perfectly as their operation in parallel. To this end a unit length of distributing station of similar relative position is devoted to the circuit and apparatus corresponding to each generator. For air circulation and ventilation and to avoid dampness from spray, as well as to insure cool generators in hot weather, a cold air supply to each generator is provided from a sub-floor chamber communicating with external shafts and heated air escapes through large roof ventilators.

"The switchboard section occupying the centre of the distributing station has four floors, of which the basement serves as a centre for the piping systems and gives room for conduits and cableways for wiring. On the main and the mezzanine or gallery floors marble slabs carry record-making and integrating instruments, terminal boards with fuses for the control cables and other adjuncts of the switchboard above. Upon the upper floor is the switchboard and controller chamber, and here instrument stands and control pedestals supplant both the

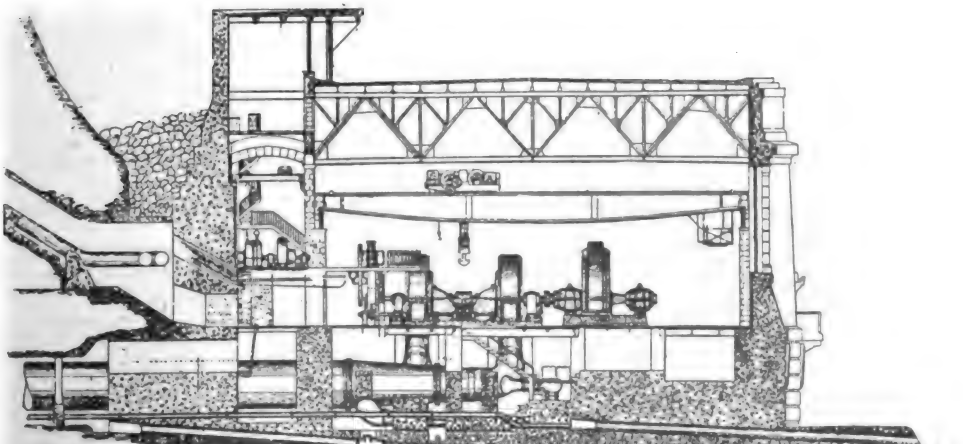


Fig. 2. Section through Power House of the Ontario Power Company.

conventional marble slabs and the later bench board. Each of the twenty-two instrument stands, which are arranged approximately in a semicircle about a central point, corresponds to a definite unit, carries nine indicating instruments, and faces its 12-point control pedestal.

"At the generating station the corresponding vantage point is the gallery, where on one side the operator has the motor-driven rheostats and a few paces distant the commutators and governors of the exciters, and on the other side in plain sight the row of main governors with their adjuncts; while from the little switchboard before him he has electrical control of penstock gates and, when necessary, manual control of turbine speeds, exciter pressure and field charge. Moreover, from this position he can see all generators and turbines and, by signal at least, can direct his assistants; little, in fact, is likely to call him to the main floor unless it be an occasional refractory journal or collector brush.

"The transformer pit, each containing a bank of three transformers, are isolated and extended to a height of 23ft. by masonry fire walls. Each individual transformer is in a boiler iron casing designed to withstand 150 pounds per square inch explosive pressure. Each case communicates through the 8in. pipe from its top with a special drain for free vent in case of accident, as proposed before the Institute some time ago; but here the supply is cold oil instead of water as then proposed. With these precautions it is believed that the transformers have been surrounded with an environment unprecedented as to safety.

"Of the features here presented it is believed that the type of intake, the symmetry of arrangement, centralisation of control and almost perfect isolation of apparatus represent, to some degree at least, distinct advances in power plant design; and while few works of such dimensions may be built for many years, if ever, it is possible that in a way some of the purposes and methods thus briefly presented may, until superseded by the next advance, be of some service as suggestions to other designing engineers of similar works. The unusual, even enormous, volumes, both of water and of power, involved not only in the individual units, but also in the aggregate, have presented new problems heretofore unprovided for in standard sizes of apparatus, thus necessitating the development of larger capacities and the creation of new types. Hence the work of designing and building has been burdened with incessant test, re-design, and adaptation unknown in more conventional engineering. Therefore, it is believed that upon no similar work in this country, since that of the Niagara Falls Power Company years ago in the infancy of electrical power, has devolved such a burden of investigation, invention and original design."

Electric Power from the Atmosphere.

SINCE the idea of electricity—for electricity is nothing more than an idea yet—first dawned on humanity, and from the time that the power of the lightning flash manifested itself, there have been rumours of men and methods for extracting power from the atmospheric representative of that potent force. Nature is reported to have selected spots and still more favoured persons on which and to whom she has revealed the secret of "tapping" these roving energies at will; but so far both these have been removed from civilised circles, being in remote corners of the earth. Our Russian contemporary, *Electritchestvo*, has recently published an article describing some experiments of a M. Michkin, in which attempts to utilize atmospheric electricity were made. Details of these were given in the *Western Electrician,* and are abstracted below as being of considerable interest.

"In 1887, near Lüttich, in Austria, lightning brought complete destruction to a bronze conductor 1.4 millimètres in diameter and 800 mètres long. In April, 1902, there occurred a case of melting by lightning of a steel wire eight millimètres in diameter and 3,500 mètres long, at the meteorological laboratory of Pavlovsk, in Russia, during the ascension of kites for experiments, which were undertaken by an international meteorological commission.

"At the time the accident took place there was only a slight tendency toward stormy weather in the atmosphere. Kohlrausch has shown that copper wire five millimètres in diameter can easily be melted by lightning, and he calculated that, to produce such an effect, a current of 52,000 amperes must flow through the wire for 0.001 of a second, or else a current of 9,200 amperes during 0.03 of a second. According to this, he admitted that the quantity of electricity accumulated in the cloud, at the moment preceding the

discharge, could be represented by a number comprising between 52 and 270 coulombs, while the intensity of current which passes through a conductor connecting the lightning arrester to the ground may reach 10,000 amperes.

"A charge of 52 to 270 coulombs can set up in a conductor a current of several thousands of amperes for a very short time. If the discharge be slow there would practically be no current, and the question therefore turns upon the finding of a motor which could work with a very small current.

"While experimenting to determine the influence due to hysteresis of the electric field upon a dielectric, Professor Arno succeeded in constructing a motor revolving in an electrostatic field and designed on a principle previously utilised by Professor Ferraris in his induction motor.

"The motor invented by M. Michkin is based on a different principle, and it differs also in details from that of Professor Arno. That principle is the rotation of a dielectric in a field of electrified sharp points. The design of the motor is very simple. A series of ebonite discs is placed, one beside the other, on a metallic axis, and can freely rotate in front of two combs which have their teeth perpendicular to the diameter of the disc. The motor is set in motion by charging one of the combs, either with positive or with negative electricity, the other being connected with the ground. The following table furnishes some data. In the table, Type I. corresponds to a motor weighing 69 grammes; Type II. to another type of 667 grammes. The values of V are given in hundreds of volts. N is the number of discharges of the condenser a minute, and W the number of revolutions a minute of the axis.

Type.	Comb Charged (+).			Comb Charged (−)			One of the Combs Charged (+), the Other (−).				
	+V.	N.	W.	−V.	−N.	W.	+V.	+N.	−V.	−N.	W.
I.	152	46	1880	158	43	2050	68	46	67	43	2260
I.	171	89	2600	176	83	2750	83	89	74	32	2900
I.	180	141	3500	174	132	3680	93	141	76	132	3950
I.	182	189	3900	189	155	4200	98	189	78	155	4750
II.	176	50	770	179	46	850	106	50	89	46	1060
II.	180	141	1000	184	132	1280	131	141	108	132	1870

"This table shows that maximum velocity takes place where the combs are charged with electricity of different signs; it becomes less when one of the combs only is charged, while the other is grounded. If one of the combs be charged negatively while the other is grounded, the speed increases. This, however, seems to depend on the surface of the teeth.

"The quantity of electricity between two consecutive discharges of the condenser was 243.10—8 coulombs; the current intensity was only several millionths of an ampere, while the tension reached 20,000 volts.

"The efficiency of the motor, as measured by the Prony brake, gave the following results:

Revolutions a minute	975	
Length of the arm	6.5	Cm.
Pressure on the arm	0.57	Grammes.
Potential difference between the two combs	232.10^2	Volts
Current intensity	320.10^8	Amp.
Outside temperature	18.7°	C.
Hydrometric coefficient	48	Per cent.

"It can be seen from the above figures that the motor could supply work to the amount of 0.038 kilogramme-mètres a second, with an expenditure of energy equal to 0.076 kilogramme-mètre, which is equivalent to an efficiency of 50 per cent.

"Having invited several persons, who showed much interest in the experiments, M. Michkin went to the mountains near Novo-Alexandria, and as soon as the kite had risen to a point fifty mètres above the level sparks began to appear in the micrometer used to measure the length of the spark. The spheres of that apparatus were then moved apart and the wire loosened. The sparks, which at first appeared every three to five seconds, changed then into a continuous stream. The motor being connected to the spheres of the micrometer, the spark disappeared, but the motor started at a speed of about 5,000 revolutions a minute, and stopped only after one hour's work, due to the fall of the wind. As soon as the wind rose the motor worked again successfully for about one hour, until rain interrupted the experiments, as none of the apparatus was sheltered. The maximum of the ascension of the kite was 120 mètres and the speed of the motor was 4,700 revolutions a minute at a pressure of 22,000 volts. The same experiment was afterwards repeated by means of a static machine, composed of twenty plates, and the speed of the motor was 4,200 revolutions, furnishing a work of 0.1 to 0.13 kilogramme-mètres a second. The author thinks that, if during the preceding experiment the kite could have been set up higher, a motor designed for a higher pressure could supply a considerable amount of work.

New York Central Power House.

FROM time to time we have referred to the pending electrification of the New York Central lines, giving particulars of the type of locomotive adopted. We can

now furnish some details of the power station for furnishing the requisite electrical energy to the new locomotives and rolling stock. We are indebted to the *Electrical World and Engineer* for these facts.

Utica, seventy-eight miles from Schenectady and fifty-three miles from Syracuse, has been selected as a generating and distributing point of power for the electric lines of the New York Central Railroad. The plan is to transmit water power to Utica and then to distribute it east and west along the lines of electric railway that parallel the New York Central. To provide for any lack in quantity or constancy of water power, a steam turbine station of 8,000kw. capacity is being erected in Utica. At first the steam power station will carry the entire electric load, as the transmission of water power to Utica is not yet under way. The steam turbine station is located on the Mohawk flats close to the point where the main line of the New York Central is joined by the Black River branch, and about 1,100ft. from the Mohawk River.

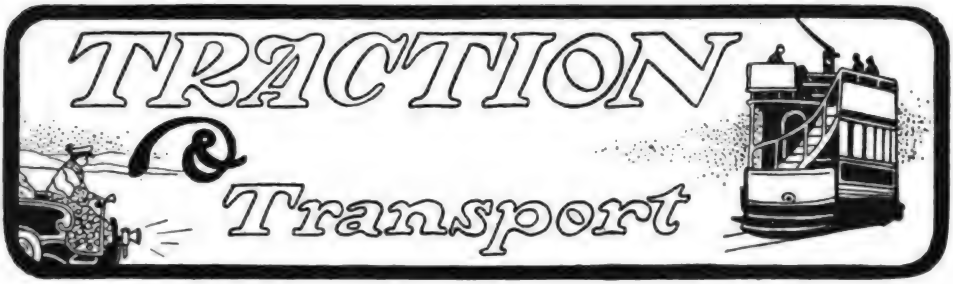
At the location of the station the flats are marshy and only a little above the level of the Mohawk, so that it has been necessary to drive piles over the entire foundation area. Because of the expiration of a certain contract under which power has been supplied to the Utica and Mohawk Valley Railroad, it was deemed necessary to have the new turbine station in operation on July 1st, 1905, and this fact has led to some exceptional methods of construction. One of these has been to build the foundations for generating equipment sooner than any other parts of the station, and then to erect the boilers and turbines before the walls were up or the roof on. The station is divided into two main parts, the boiler room and the turbine room, by a steel and masonry wall that rises to the roof. In elevation the boiler room is divided into basement and main floor and the turbine room has a basement, main floor, and gallery floor. On that part of the gallery that is mostly above the oil switch room are located the low-tension transformers, rotary converters, and operating switchboards. Above the gallery floor is a travelling crane that sweeps the entire space 8ft. wide over both the turbines, transformers, and rotaries. The boiler room is designed for sixteen 500h.p. horizontal water-tube boilers arranged in two rows with fronts facing each other along the centre of the room, in the direction of its greater dimension. Over the central space between the boilers runs the coal conveyor that feeds the automatic stokers. Both rows of boilers are connected to lines of main and auxiliary headers, near the wall between the boiler and turbine rooms, and from these headers a pipe carrying a separator passes through the wall and to each turbine. Ashes from the boilers drop to pits in the basement beneath, and are thence conveyed to the railway outside. The furnaces operate with induced draught provided by steam-driven blowers, and the products of combustion pass to the outside air through short steel stacks. Water for the boilers passes through a Cochrane heater of 6,000h.p. rating, and as surface condensers are employed to handle the exhaust steam, the boiler water is used over and over.

In the turbine room foundations are provided for five vertical Curtis generators, two of which will be of 1,000kw. and three of 2,000kw. each, thus giving the total capacity of 8,000kw. Each of the 1,000kw. units is conected to a surface condenser of 3,500sq. ft., and each of the 2,000kw. units to a condenser of 6,850sq. ft., both of the Worthington make. Each of the turbo-generators develops three-phase current at 40 cycles per second and 2,300 volts. This current all goes to transformers by the way of oil switches, save that consumed in the 2,300 volt induction motors at the generating station and the pump house. Exciting current for the turbine generators is supplied by two dynamos, each of which is direct-connected to a 2,300 volt, 40 cycle, three phase induction motor.

On the gallery floor at one side of the turbine room space is provided for the motor-driven exciters, for transformers, and for rotary converters and reactive coils, besides the switchboard and bench-board. Beneath this gallery is the oil switch room and the space for the high-voltage transformers.

Each of the 1,333kw. transformers will be single-phase, and they will, therefore, be connected in five groups of three each to handle the three-phase current from either the turbine generators or from water power plants. These five transformer groups will have a combined rating of 20,000kw. Each transformer has one set of windings for 2,300 and the other set for 17,100 volts. The 17,100 volt winding is in two parts, and when these parts are connected in series the winding either takes or delivers current at 34,200 volts. When the 2,300 volt winding is used as the primary, taps in that winding make it possible to develop either 20,000 or 30,000 volts in the secondary coils, according as they are connected in multiple or in series.

It was April 16th, 1905, when the flats where the new plant is located were dry enough so that work could begin, and the station is at present ready for operation. So great has been the haste on this station that the General Electric Company, which is supplying the electric equipment, has been unable to deliver the 1,000 and 2,000kw. turbines when they were wanted, and has loaned some 500kw. turbine units until the larger machines can be completed. — *Electrical World and Engineer.*



A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

London Traffic Commission.

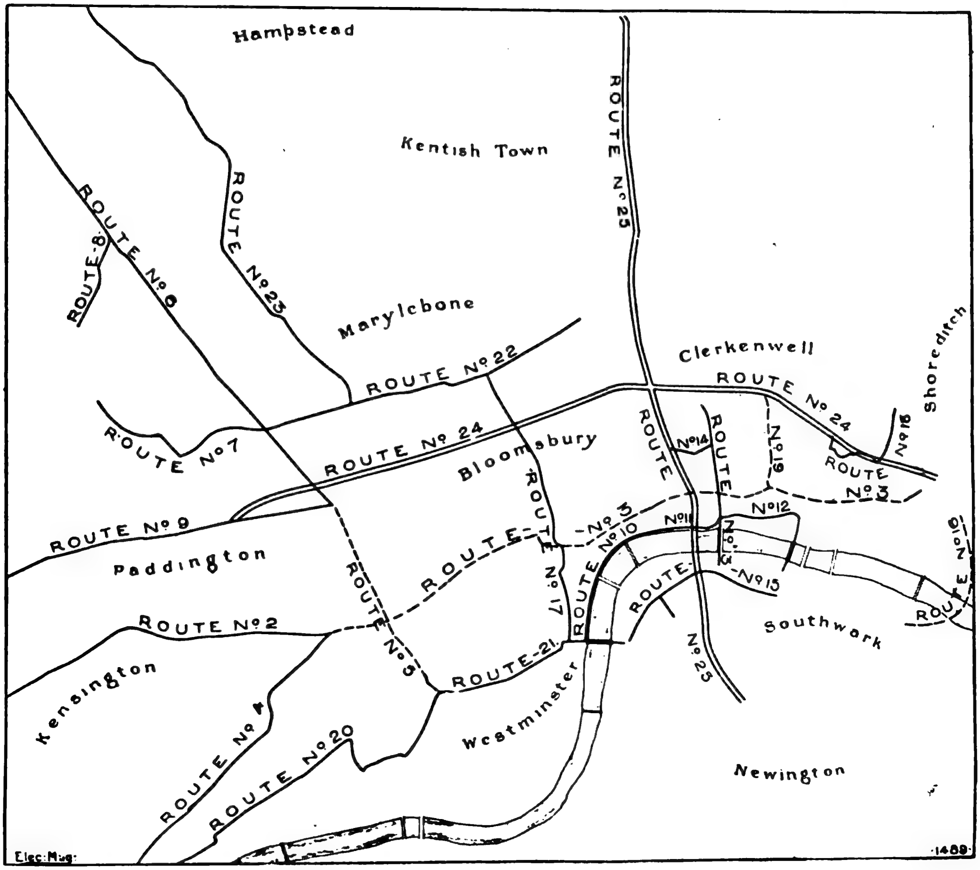
We remarked editorially last month on the issuance of its report by the Royal Commission on London Traffic, and announced our intention of giving fuller details in this issue. We commence these by a summary of the chief conclusions, and follow with abstracts from the various sections of the report.

"It is imperatively necessary, in the interests of public health and public convenience, and for the prompt transaction of business, as well as to render decent housing possible, that the means of locomotion and transport in London and its adjacent districts should be improved: they are seriously defective, and the demands and needs of the public are annually increasing. The main obstacle to such improvement is the narrowness of the streets, which were not laid out in accordance with any general plan. The arterial roads leading out of London largely suffer from the same defects. A comprehensive plan for the improvement of streets and main roads should be prepared and carried out continuously, as financial considerations will allow. We have suggested some improvements; many more might be suggested, but the difficulty is one of money, and progress must be gradual. Increased modern means of locomotion and transport are much needed, both to facilitate movement within the central area, and to facilitate access to and from and within the suburbs for those who work in London and live outside. Electric tramways and railways are necessary for both these purposes; tramways mostly for the former and railways mostly for the latter, with intercommunication between the two.

"The tramways system of London is disconnected and insufficient. It should be largely extended, and the portions of the tramway system that are now isolated should be linked together, through communication being provided from east to west and from north to south. We believe that much could be done in tramway development without having recourse, at any rate in the first instance, to great and costly street improvements; but, as such improvements are unavoidable, in any case, the preference should be given to those which will facilitate the extension of the tramway system.

"The absolute 'veto' over the construction of tramways passed by local and street authorities should be abolished throughout the area of 'Greater London,' but with a preferential right to county councils, and the Corporation of the City of London, to construct tramways within their districts, if they are prepared to do so. Tramways should run through from side to side of London, so far as possible, and termini, in the streets and central districts, should be avoided. In regard to railways, their further development must be governed by the features of the existing and authorised systems, which should be extended and improved. We have suggested various extensions and improvements. It is important that all possible facilities should be afforded to suburban passengers, arriving at the terminal stations, to reach their destinations throughout the central area by railway, either by means of through trains, or by interchange within the stations to which the suburban trains may run.

"Owing to the high capital cost of 'tube' railways, constructed under present conditions, there is a difficulty in providing a



ROYAL COMMISSION ON LONDON TRAFFIC: KEY TO TRAMWAYS PLAN.

2. Hammersmith to Knightsbridge. 3. Knightsbridge to Aldgate (Subway). 4. Fulham and Brompton Roads. 5. Grosvenor Place and Hyde Park (Subway). 6. Edgware Road and Maida Vale. 7. Harrow Road. 8. Cambridge Avenue. 9. Uxbridge and Bayswater Roads. 10. Westminster Bridge and Victoria Embankment. 11. Waterloo Bridge to Blackfriars Bridge viâ Victoria Embankment. 12. Queen Victoria Street and Southwark Bridge. 13. New Bridge Street and Farringdon Street. 14. Holborn and Charterhouse Street. 15 York Road, Stamford Street, and Southwark Street. 16. Tower Subway. 17. Tottenham Court Road and Whitehall. 18. Moorgate, Liverpool Street, and Norton Folgate. 19. Aldersgate Street to Post Office (Subway). 20. King's Road, Chelsea, and Buckingham Palace Road. 21. Victoria Street, Westminster. 22. Marylebone and Euston Roads. 23. Finchley Road. 24. Suggested East to West Main Avenue. 25. Suggested North to South Main Avenue.

sufficient number of such railways to distribute population over the outlying districts; but we are advised that it is possible to construct a cheaper type of deep-level railway adapted for suburban traffic, with fewer and less expensive stations, and rising to the surface when the open country is reached: such railways would help to solve the 'housing problem' by carrying the population to districts not yet built over.

"If private enterprise will not construct the necessary railways, the local authorities might be authorised to give assistance in view of the fact that re-housing within the central area involves a heavy loss to the rates, and that it may be cheaper, and will be better in other respects, to help in making healthier residences in the suburbs accessible. In cases where railways exist, but additional train services are required to open up new districts for building, and railway companies decline, and cannot, under the existing law, be compelled, to put on additional trains, local authorities might be empowered, if the necessity is urgent, to guarantee, for a limited period, such net receipts per train-mile for the proposed trains as may be reasonable."

In the opening remarks the Commissioners state:

"There is no finality in the question of the best means of locomotion and transport for great cities; and, in the case of London, it

is necessary, in a very special degree, that the problem should be considered, in the first instance, on broad and general lines, and that, subsequently, a series of separate and distinct enquiries should be undertaken in order to deal with particular branches of the subject. Continuous attention is required in order to ensure that the practical measures, which these enquiries may show to be expedient, shall be brought into harmony with each other and with a general plan, as well as to provide the means of meeting new wants, and to take advantage of fresh scientific discoveries affecting the provision of the means of locomotion and transport.

"For these and other reasons, which we shall state at greater length hereafter, we have come to the conclusion that the appointment of a permanent body to deal with questions of London locomotion is expedient. The constitution of the new authority, and the powers which it should possess, could not, however, be satisfactorily determined without a full examination of the nature of the problem, and some enquiry into the merits of the suggestions we received. In this view of the question, we have not merely taken evidence of a general character, but we have, by a special arrangement, obtained expert and technical advice on certain matters of primary importance. One of the members of the Commission, Sir John Wolfe Barry, K.C.B., Past-President of the Institution of Civil Engineers, undertook to act on and preside over the Advisory Board of Engineers whom we consulted, and we were fortunate to obtain the services of Sir Benjamin Baker, K.C.B., K.C.M.G., Past-President of the Institution of Civil Engineers, and Mr. William Barclay Parsons, M.Inst.C.E., Chief Engineer to the Board of Rapid Transit Railroad Commissioners of the City of New York, who was well acquainted with London.

"We think it right to say, at the outset, that we have not attempted to pass judgment upon the projects of particular promoters that have been or are before Parliament, or to discuss their relative merits: We do not understand that we are authorised to do so by the terms of our Commission, and, in any case, we could not satisfactorily pronounce upon such matters, involving, as they do, private as well as public interests, without the same detailed assistance from counsel and witnesses that is given to Select Committees of Parliament."

On the question of tube railways the report contains the following:—"It is obvious that the deep-level railways as they exist in London have been designed and laid down in accordance with the proposals of different promoters, without special examination beforehand of the whole problem, and without continuous control by a single authority. The Metropolitan Board of Works was abolished in 1889, and the London County Council was established in the same year, but the latter body was not given any authority in connection with railways proposed to be constructed in the Metropolis. The construction of such railways was left to private enterprise, and the promoters obtained their authority to construct by means of private Bills. The London County Council had no power to control the construction of such railways, and an attempt to exercise, in the interests of the public, such control as is possible by formal opposition to private Bills does not give satisfactory results, while it adds to the cost of the undertaking, and tends to produce a state of antagonism between the companies and the Council, which is greatly to be regretted, and is detrimental to the public interests."

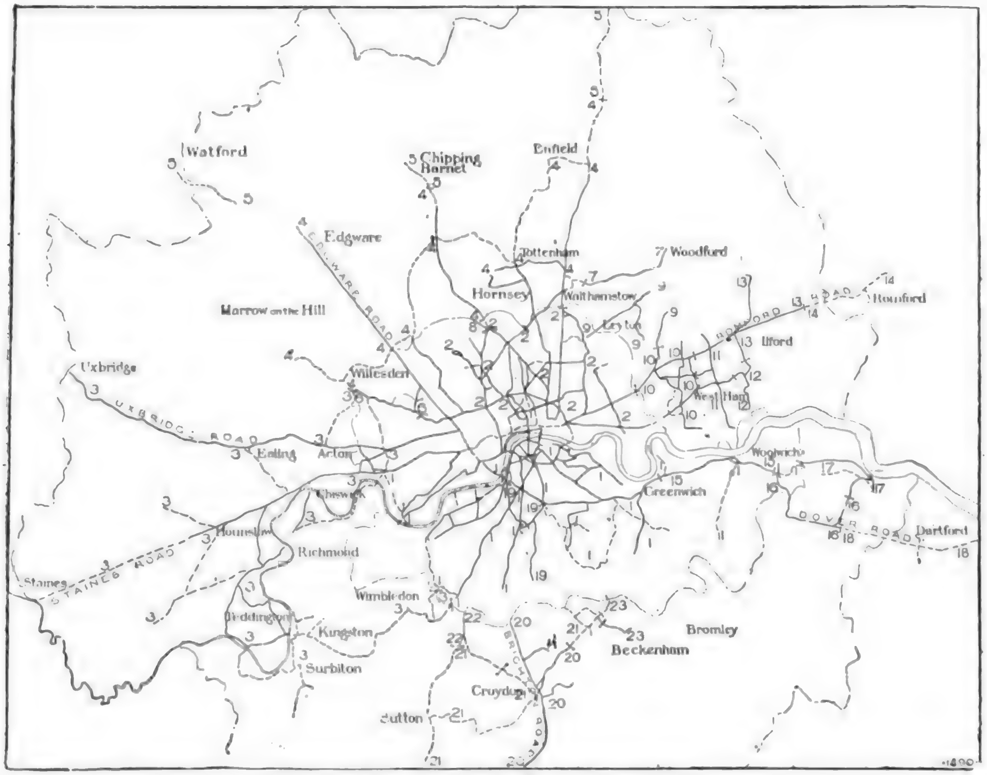
Street Improvements.

The proposals for street improvements were remitted to the Advisory Board of Engineers, and although they have not drafted any complete plan, they advise the execution of certain improvements. These include the construction of two main avenues through London, one 4¾ miles from Bayswater Road to Whitechapel, and the other 4½ miles to connect Holloway with the Elephant and Castle. Each would be 140ft. wide, from house to house, with four lines of surface tramway and four lines in subway for express and stopping trains. These tramways would connect the tramway systems at both ends, and traffic with other tramways on the route could be interchanged. The lines in the subway would be coupled to the various railway systems. The Bayswater-Whitechapel avenue completely equipped is estimated to cost about £15,550,000, and the Holloway-Elephant avenue about £8,550,000 net. The Commissioners refer to New York, where an electric subway, for express and local trains, has been built at municipal expense by a company under contract for construction and operation at an annual rental which will defray interest and sinking fund on the municipal bonds issued for the work. A further method of finding the capital is proposed, *i.e.*, an extensive purchase of back lands near one of the selected routes at present values.

Recommendations as to Tramways.

At the end of 1904 there were 203 route miles and 26 chains of tramways working in "Greater London," and 146 miles and 68 chains authorised.

The L.C.C. comes in for some sharp criticism, as the following remarks of the Commissioners show:—"Within the County of London nearly the whole of the tramways are owned, and in great part are worked, by



ROYAL COMMISSION ON LONDON TRAFFIC TRAMWAY PLAN:
1. L.C.C. 2. L.C.C. (worked by North Metropolitan). 3. London United. 4. Middlesex C.C. (worked by Metropolitan Electric). 5. Hertfordshire C.C. (worked by M.E.). 6. Harrow Road and Paddington. 7. Walthamstow U.D.C. 8. Highgate Hill (Cable). 9. Leyton U.D.C. 10. West Ham Corporation. 11. East Ham U.D.C. 12. Barking U.D.C. 13. Ilford U.D.C. 14. Romford. 15. Woolwich and South-East London. 16. Bexley U.D.C. 17. Erith U.D.C. 18. Dartford U.D.C. 19. London Southern. 20. Croydon Corporation (worked by British Electric Traction Co.). 21. Croydon and District (worked by B.E.T. Co.), 22. Mitcham Light Railways (worked by B.E.T. Co.). 23. Beckenham U.D.C. (worked by B.E.T. Co.).

the London County Council, whose policy has been consistently directed to the exclusion of private promoters from within the County of London; such tramways within their jurisdiction as do not already belong to them will be acquired, under existing statutory powers, in the course of a few years. In the district of 'Greater London,' lying outside the Administrative County of London, a different policy in general prevails; the tramways are largely worked by private companies. This difference of policy would not necessarily entail inconvenience if the systems on the outside were worked in harmony with those inside, so that cars should run continuously across the frontier. Unfortunately that is not the case. The systems, where they meet at the frontier, are not always physically connected, and in no case is there through running. Inside the Administrative County of London itself, there are also very serious defects. Three systems of tramways are included in this area: the northern and eastern system, wholly north of the Thames; the western system, also wholly north of the Thames; and the southern system, wholly south of the Thames. All these three systems are separated from each other by long intervals, without any connection, as will be seen by a reference to the tramway plan herewith; while great districts in the centre of London, including the City, the 'West End,' and the chief places of public resort, are entirely unprovided with tramway service.

"As a result, all the cars are obliged to discharge their passengers at dead-end terminals. At the six principal terminals (Westminster Bridge, Shepherd's Bush, Blackfriars Bridge, Aldgate, Moorgate and Euston Road) nearly a quarter of a million of passengers alight from or join the cars every day in the streets. Apart from the great inconvenience caused to all or most of the passengers, the result is a great congestion, both of tramcars and of ordinary vehicular and pedestrian traffic, at these terminal points; and the same congestion, though in a less degree, occurs at the other terminals in London. The Advisory Board of Engineers estimate that the carrying power of a tramway system may be

diminished by about one-half by reason of the cross shunting necessary at dead-end terminals. In the absence of delay from this cause 150 cars or upwards per hour might be run on a single track, even in busy thoroughfares; but at Westminster, for example, where a number of cars from different lines converge at the Lambeth end of Westminster Bridge, the necessity for cross shunting creates so great a delay that all the lines taken together cannot run more than 72 cars per hour in one direction, and that only under pressure."

The utmost emphasis is laid on the present state of tramway matters in the Metropolis, and on this point the Commissioners lay great stress.

"It will be seen that, from every point of view, tramway accommodation is glaringly defective, and it is difficult to appreciate how such a state of things can have been tolerated so long. Whatever view may be held upon the expediency of extending tramways in London, it cannot be expedient to work those we have upon inefficient methods."

The horse omnibus will always serve a useful purpose in London, unless superseded by the motor omnibus, in distributing passengers where tramways do not penetrate, but we believe that on all the routes, where there is fair competition, the same thing will happen in London as happened in Liverpool between the years 1897 and 1903: within a period of seven years all the omnibuses disappeared from the streets, and gave place to electric tramcars, while the number of passengers carried was nearly trebled. On routes suitable for tramways, where there is a large traffic, tramways will continue to be the most efficient and the cheapest means of street conveyance, and we cannot recommend the postponement of tramway extension in London on the ground of any visible prospect of the supersession of tramways by motor omnibuses.

In addition to the proposal already noticed for two main avenues with tramways on the surface, the Advisory Board of Engineers further propose that tramways should be laid on the routes shown in the map herewith, after making the necessary street improvements.

"*The City.*—As to the proposals within the City of London, some involve subways, others are for surface tramways. The position of the City is peculiar: in no district of London is the congestion greater or relief more urgently needed. The streets in the more crowded parts of the City are not wide enough to admit of surface tramways, having regard to the immense traffic passing over them, and widening is quite impracticable, because of the value of land. In these circumstances, relief can be afforded only by subways, which must be very costly. It is in these respects that the proposed new avenues offer so many advantages, inasmuch as they provide for railways in subways as well as for surface lines of tramway. We think that surface tramways should be laid down in the City of London where they can be shown to be reasonably practicable, and that subways should be made where surface tramways are not practicable.

Summary of Tramway Recommendations.

"We recommend:—A large extension of tramways in London and the suburbs; that immediate attention be given to providing through communication between the different tramway systems within the Administrative County of London; across the Thames by the Westminster and Blackfriars Bridges; and that provision be made for through running inside and outside the Administrative County of London. Any great increase of tramways, such as we anticipate, would lead to the necessity of organisation for the purpose of securing the harmonious working of the separately-owned systems. We rely on the action of the proposed Traffic Board to protect the interests of the public, and think the Board should insist, wherever practicable and desirable in the public interests, on through communication without the passengers being required to change cars, such through communication being enforced, if necessary, by the grant of running powers, subject, of course, to approval by Parliament. We have been told by witnesses that from this point of view the various tramway systems within 'Greater London' ought to be worked by one and the same authority, and that for this and other reasons it is inexpedient for the London County Council to operate their own tramways.

"So far as the question involves considerations of municipal trading, we do not think it is within our province to express an opinion. We think it reasonable that some profit should be derived from the tramways for the benefit of the municipality, but it does not follow that the best way of securing the largest profit will be that the municipality, even if it finds the money for construction, should undertake the task of operating. In other countries, it is not unusual for municipalities to construct, purchase or otherwise acquire the tramways, but in such cases the actual working is generally left to operating companies, with provision for proper rates and general control. It is claimed that such methods yield better financial results to municipalities, and avoid difficulties which might arise from municipal authorities carrying on a business of this kind on a large scale. The matter is one of such importance that, having regard to the conflicting views that have been laid before us, we strongly recommend that the whole question of the

expediency of the working of large tramway systems by municipalities be specially investigated."

On the important and much-discussed matter of the "veto" the Commissioners remark:—"We have come to the conclusion that the best course is to abolish the 'veto' in all cases, but to provide that, in 'Greater London,' the county councils and the Corporation of the City of London shall have a preferential right to construct any tramways, within their districts, if they are prepared to do so. We consider it unreasonable that one portion of a district should be in a position to put a stop to the construction of a general system of tramways required for the public benefit, without even allowing the case to be presented for the consideration of Parliament. In so far as the 'veto' fetters the discretion of Parliament, a remedy can be applied by modifying Standing Order No. 22. It appears to us that, instead of a 'veto,' it would be sufficient that local and road authorities should have a *locus standi* to appear before the proposed Traffic Board and Parliament, in opposition to any tramway scheme within their districts, by whomsoever such tramway scheme might be promoted. In the same way it may be quite right that the frontagers, who have at present a 'veto' under the Tramways Act, 1870, should be entitled to oppose the construction of tramways. There can, however, be no valid ground for allowing them to prevent proposals from being even considered. We accordingly recommend that the frontagers' 'veto' be abolished, and that those who now possess it should have a *locus standi* upon any tramway scheme affecting their property.

Railway Recommendations.

"*Tube Railways.*—We have come to the conclusion that, when the 'tube' railways already authorised have been completed, with the addition of the lines we have suggested from Victoria to Marble Arch, the most pressing requirements of railway communication within the central area, as distinguished from the suburbs, will have been fairly provided for. We think, however, that greater attention should be paid to providing interchange stations, wherever lines running north and south intersect those running east and west; and that, wherever it is possible, this accommodation for the public should be afforded. We think also that, in regard to both the suburban and central urban railway systems, there should be better connection to the north-east of London; and better connection between the suburban systems on the east and the suburban systems on the west, with the object of improving central urban communication, and providing passengers with fuller facilities than they now possess, by convenient interchange stations, for reaching all principal points within the central area served by the central urban railways.

"*Railways in Shallow Subways.*—We have given much consideration to the question whether future railways in the central area and in the outer areas, which are already being covered with buildings, should be made in shallow subways or in deep-level 'tubes.' Experience has, however, proved that the cost of 'tube' railways, including the cost of the shafts and lifts, approximates to the cost of 'shallow' railways under similar conditions of location. It has been proved before us that the cost of working the lifts is a very serious addition to the working expenses of each 'tube' line. It has been calculated, in the case of the Central London Railway, to add 8 per cent., or over £8,000 each half-year, to the total expenses. This is a continuous expense, and, if it be capitalised, it would, to that extent, neutralise any relative cheapness in construction. These observations as to comparative cost refer to 'tube' railways of the type hitherto constructed with lifts and frequent stations. Wherever it is at all practicable, it is most desirable that urban railways, traversing London from side to side, should have four lines of way, in order to provide a separate service for express and for stopping trains, and thus admit, by means of comparatively few interchange stations, of rapid transit to the suburbs from all the stations on the local service lines. This system has been carried out lately in New York, and has proved itself to be a great success, being an admirable way of combining transit facilities for urban and suburban traffic.

"*Operation of Urban Railways and Tramways in Large Systems.*—It is only by extensive amalgamations that the great advantages arising from unity of interest and unity of management can be fully realised. We believe that amalgamation can be carried out in such a way as to be profitable to the shareholders, and advantageous to the public, but we think that it should only be sanctioned on terms and conditions which fully secure the interests of the public. In this connection our attention has been called, on behalf of the London County Council, to the controlling power which has been secured by the Underground Electric Railways Company of London, Ltd., over the Baker Street and Waterloo Railway, the Charing Cross, Euston, and Hampstead Railway, the Brompton and Piccadilly Circus Railway, and the Great Northern and Strand Railway, the two latter having been amalgamated into the Great Northern, Piccadilly, and Brompton Railway. The Underground Electric Railways Company also exercise a powerful influence over the London United Tramways Company and the Metropolitan District Railway Company.

The London Underground Electric Railways Company is not a statutory company, but the enterprises which it now controls or influences were, or are being, constructed under statutory authority, and remain, even when under the control of a limited liability company, such as the Underground Electric Railways Company, subject to all the conditions imposed on them by statute; but it obviously would be of advantage in a matter of so much importance to the general public that the conditions under which amalgamation, of a more or less complete nature, takes place should be examined and approved by some public authority. Mr. Charles T. Yerkes, Chairman of the Underground Electric Railways Company of London, who has also lately succeeded Mr. R. W. Perks, M.P., as Chairman of the Metropolitan District Railway Company, informed us that he would be prepared to lay the whole scheme for amalgamation before Parliament, and take a decision on the merits. Under these circumstances, we do not think it is necessary that we should say anything further on this subject in the present report. We are satisfied that the formation of the Underground Electric Railways Company of London has been of material assistance in raising the capital for works which will be of great public benefit."

The Use of Portable Substations.

AMERICAN practice in the field of urban electric railways has conclusively proved the value of the portable substation as a necessary expedient on lines having a normally light traffic but subject to heavy rushes of load at certain times. Numerous types of these portable stations have been put into service, and considerable interest attaches to their equipment. In a recent issue of the *Street Railway Journal* Mr. J. R. Hewett described a station built for the Cincinnati and Columbus Traction Company. From this article we cull the following data:—The equipment under consideration at present forms a 400kw. plant. In this instance the machinery and apparatus are installed in a freight car of standard design. Great attention has been paid to the location of the heavier units, to avoid undue strain being brought on any part of the car or machinery during the time it is in motion. The rotary converter is placed at one end of the car and the transformer at the other, in each case the centre of gravity being immediately over the truck. An equipment consisting of a rotary converter and transformer has been found by experience to be preferable to employing a synchronous motor generator set. The former not only has the advantage as regards weight, but it is also less costly, has a better overload capacity, and the connections are simpler. Added to this, were a motor generator set installed, it would involve the use of an exciter set and a high-voltage starting compensator and switches.

The rotary converter installed in the Cincinnati and Columbus substation is a six-poled, three-phase machine, with a normal output of 400kw. when running at 500 revolutions per minute. The potential at the d. c. brushes is 600 volts. It is fitted with a speed-limiting device connected up in such a manner as to

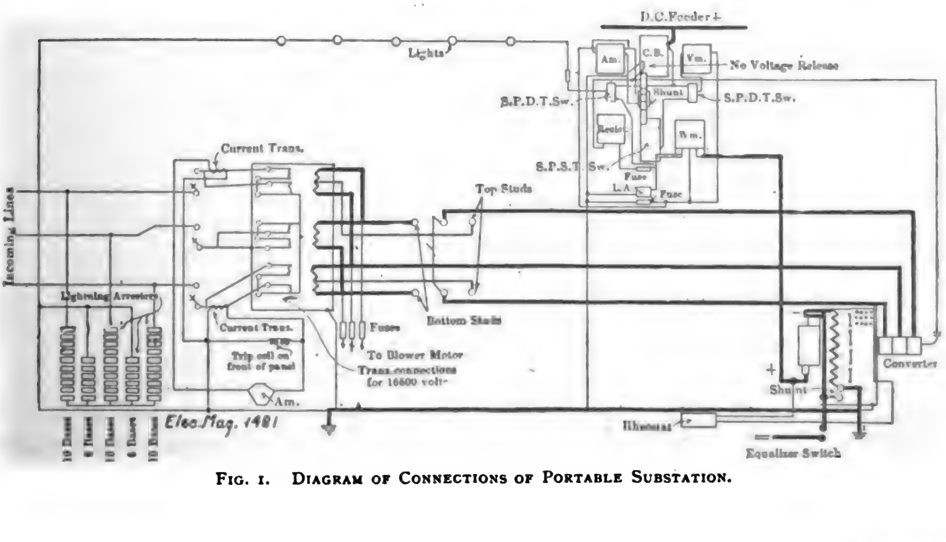


FIG. 1. DIAGRAM OF CONNECTIONS OF PORTABLE SUBSTATION.

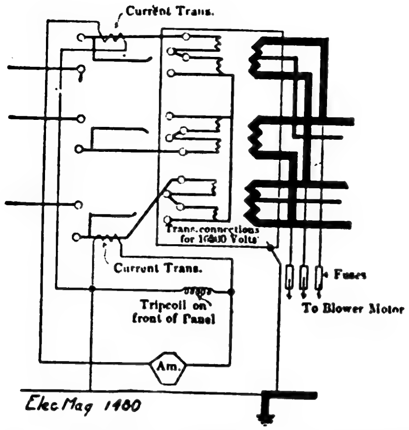


FIG. 2. TRANSFORMER CONNECTIONS FOR PORTABLE SUBSTATION.

open the d. c. circuit breaker in case the speed rises above the normal, due to a failure in the a. c. power circuit, when the converter would run as a d. c. motor with a differential field.

In the early portable substations three single-phase transformers were employed. But this was only due to the fact that such apparatus could be obtained at the works ready for immediate use. In the present case, one tri-phase transformer has been installed, and this arrangement possesses the two-fold advantage of being light in weight and occupying a minimum floor space. It is designed for a capacity of 440kw., is a 25 cycle unit, and the primary is wound for both 33,000 and 16,500 volts, while the secondary delivers current at a pressure of 370 volts. The blower set for supplying the air-blast consists of an ordinary rotary blower, direct-coupled to an induction motor. No high-tension apparatus is brought in front of the transformer, a factor which ensures the safety of the substation attendant. The usual form of low tension a. c. starting switch is retained, and no d. c. starting rheostat switch or synchronising apparatus is included in the equipment. Both power factor indicator and a. c. voltmeter are also dispensed with. No negative switch is provided, the negative terminals of the machine being connected directly to the metal truck, which is, of course, in metallic connection with the track. The rotary converter is compound wound, with the series coil on the negative side—that is to say, between the armature and ground connection. An equaliser switch is provided on the negative side of the machine for use when the car is in operation as a reserve to a permanent substation close at hand. The equaliser switch running to a flexible jumper can readily be connected to the equaliser bus bar in the neighbouring substation; and, again, the jumper can be connected to the ground should it become desirable to run the converter as a shunt-wound machine.

The substation can be lighted from either the trolley or the rotary converter; and the voltmeter is provided with a double-throw switch to permit readings being taken of either the trolley or machine voltage at will. A flexible lead is taken through the wall of the car directly from the machine circuit breaker to a terminal block on the outside, so that connections may readily be made to the trolley wire, d. c. feeder, or positive bus bar in the permanent substation, as occasion demands. The a. c. leads are carried out through a special weather-proof entrance, and from this point connections are made to the overhead high-tension transmission lines.

The end of the car near which the rotary converter is located is made detachable, to facilitate installation. The rotary converter is held in position by wooden cleats, which fit snugly to the interior form of the base, and provision is also made for levelling the rotary converter, should it be found necessary for the substation to be operated on a grade. All the wiring from the transformer to the rotary converter is carried under the floor.

Figs. 1 and 2 show the scheme of connections diagrammatically. In the former the transformer connections are for 16,500 volts, and in the latter for 33,000 volts.

The approximate dimensions of the car are:

Length	41ft.
Width	9ft.
Height	8ft. 6in.

The car is fitted with hand brakes, but no motors are installed, as their occasional use would hardly justify the extra expense. When the substation is moved, it is drawn by a motor car. During transit over the steam railroads, standard M. C. B. wheels are used, but when the car reaches its destination, these are replaced by wheels of narrower tread and shallower flanges, suitable for running over city lines, switches and points, as well as rounding curves, &c. Cars for operating on lines where little clearance is provided between the top of cars and bridges can be supplied with hand-brake rigging mounted below the roof line.

Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

*A New Carbon Filament.**

By JOHN W. HOWELL.

In briefest outline, the new characteristics of the filament may be said to be due to the proper application of excessively high temperatures to the ordinary carbon filament. The value of the product is determined by the conditions under which the high temperatures are applied. To produce the effects described in this paper the heat is externally applied to treated filaments at atmospheric pressures. The simple application of the highest attainable temperatures to the plain carbonised cellulose fibre, *i.e.*, the so-called "filament base," is also incapable of producing any considerable change in the filament. This high temperature treatment of the base is, however, a beneficial step in the process here described.

In attempting to graphitise carbon filaments it was discovered that treated filaments undergo very remarkable changes when subjected to the highest possible temperature of an electric-resistance furnace. The furnace consisted of a carbon tube, held at the ends by large water cooled copper clamps; the tube was embedded in powdered carbon to prevent its combustion. The filaments were packed in small cylindrical boxes, which were fed into the heated tube. The temperature was usually between 3,000 and 3,700°C. Under such firing the ordinary treated filament changes in appearance; its graphite coating looks as though it had been melted, and its specific resistance is greatly reduced. The resistance of one of these filaments, measured at ordinary temperature, may be reduced as much as 80 per cent. by the firing.

The curves representing the resistance at different temperatures are also remarkable. Fig. 1 shows curves of resistance and temperature of a regular base filament, a base filament fired a regular treated filament, a treated filament, fired, a shell of regular treated filament, and a fired shell. The resistance in ohms is plotted against the temperature, as indicated by the percentage relation of the pressure on the filament to the normal pressure at which the filament

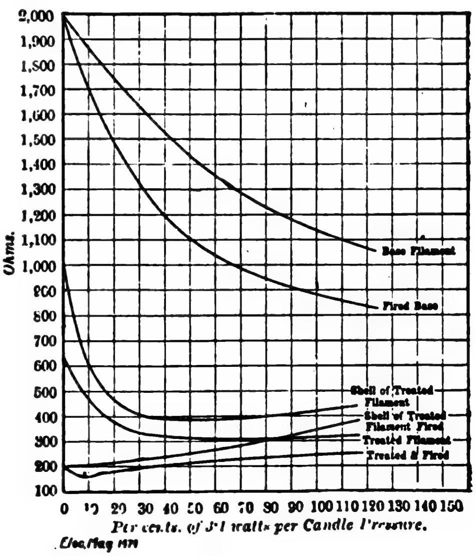


Fig. 1.

* A paper presented to the American Institute of Electrical Engineers.

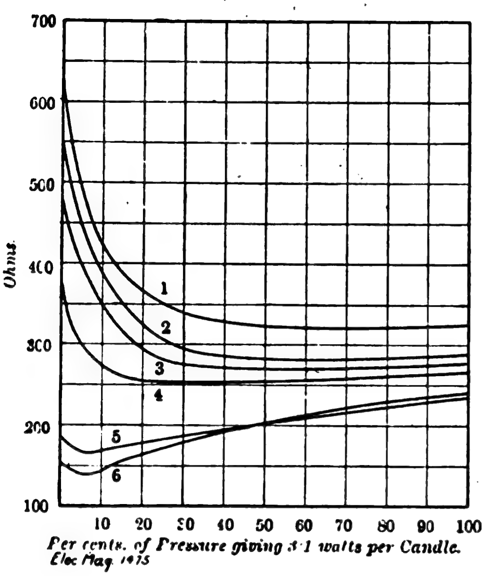


FIG. 2.

has an efficiency of 3.1 watts per candle. The curves show a more rapid fall in resistance of the base filament after firing, but little change in the character of the curve.

The change produced in the treated shell by firing is very great, the cold resistance being reduced from 1,000 to 200 ohms, while the great change in the character of the curve of the fired shells brings the hot resistance of the two shells nearly together.

The resistance curve of a fire-treated filament depends upon the relative thicknesses of base and coating, and upon the temperature of firing. Figs. 2 and 3 show curves of filaments fired at five different temperatures and of a similar filament that has not been fired. In Fig. 3 the resistances are shown in percentages of the cold resistances, and in Fig. 2 the actual resistances are shown.

These filaments were heated in the carbon tube resistance furnace. They were enclosed in a cylindrical carbon box, placed inside the tube, one end of which was left open for observation. An indication of the temperature was obtained by looking directly into the open end of the tube at the box holding the filaments, and holding in the line of vision the filament of an ordinary 50 volt lamp, the temperature of which was adjusted until the filament became invisible against the incandescent carbon box. The pressure on the lamp was then observed, and the box of filaments taken out.

Curve No. 1 is the resistance curve of a regular treated filament. Curve No. 2 is the curve of a similar filament heated in the tube to a temperature corresponding to the temperature of a carbon filament operating at 153 per cent. of its normal pressure, or at 125 candles for a normal 16c.p. lamp. Curve No. 3. is the curve of a filament fired at a temperature corresponding to the temperature of a lamp at 161 per cent. of its normal pressure, or at 163 candles. Curve No. 4, 183 per cent. of normal pressure, or at 230 candles. Curve No. 5, 200 per cent. of normal pressure, or at 280 candles, for a 16c.p. lamp. Curve No. 6 is the curve of a filament heated hotter than No. 5. The temperature was not measured by this method for fear of breaking the comparison lamp.

Fig. 4 shows the resistance curve of a filament made from a thin base having quite a thick treatment; this shows a resistance increasing to 250 per cent. of its cold resistance. The change in the resistance curve of this coating from negative to positive seems to be due, in part at least, to the action upon the shell of some substance driven out of the base filament by the high temperature. This is indicated by the considerable change in the curve of a treated fired filament produced by heating the base filament to the same high temperature before it was treated and then reheated.

Fig. 5 shows resistance curves of carbons

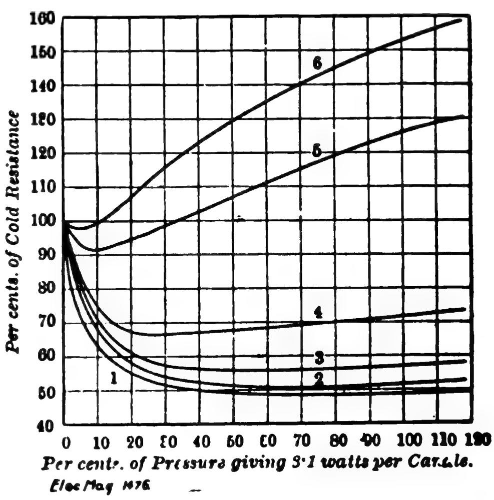


FIG. 3

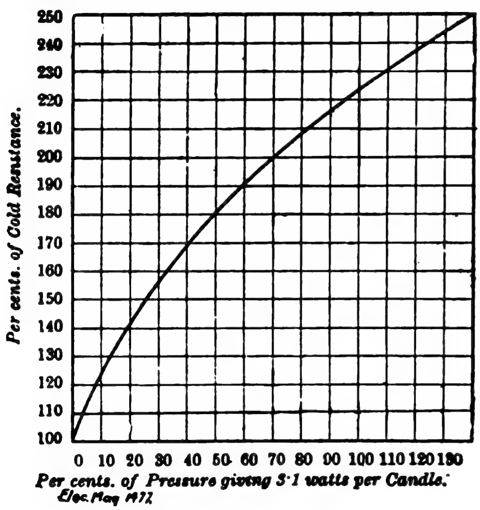


FIG. 4.

fired at the same temperature after treating, but with the base fired at different temperatures before treating. The base filament in Curve A was unfired; in B, C, D, and E the base was fired at successively higher temperatures.

The curves made from filaments, the bases of which have been heated to high temperatures before being treated, are much less positive than the others. The conclusion that the effect is produced by material being driven out of the base seems to be borne out by the fact that during the preliminary heating of the base at high temperatures it loses practically all of its mineral ash constituents, and also by the fact that, if some of the elements that the base loses in its high heating be separately placed in the furnace with the treated filaments, effects are produced similar to those observed when the base has not been previously heated.

The effect of some agency besides heat is also indicated by the fact that the lamp filament used in the temperature observations,

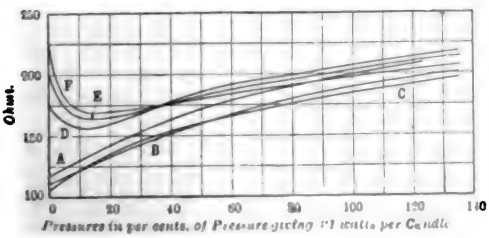


FIG. 5.

although maintained at the same temperature as the filaments in the furnace, and for a sufficiently long time, showed no indications of such a change as was produced in the filaments in the furnace. The appearance of a filament fired both before and after treating is very different from that of one fired after treating only. The former has a slightly pebbled appearance, as seen through a microscope, and a rather dull-grey colour.

The single-fired treated filament is generally very much blistered, many blisters extending outward a distance greater than the diameter of the filament. These blisters indicate an outflow of gas from the base where the shell was in a soft condition. The surface of the filaments is highly lustrous. The specific resistance of the highly heated coating has been found to be as low as 0.00006 ohm per cubic centimètre, which is very much lower than the specific resistance of any other known form of carbon or graphite.

Its specific gravity is also much higher than it was before heating. Its changed nature is also indicated by its toughness and flexibility. The coating of a double-fired filament may be pulled off in short tubular sections, which, if pressed flat, will spring back to their original form when the pressure is removed. The same coating before being fired is comparatively brittle, and will break with very little pressure. On account of the positive resistance curve and physical characteristics of these filaments, they have been given the name "metallised filaments."

The treated coating on filaments even before firing is graphite, as determined by the chemical test established by Berthelot—the production of graphite acid (a yellow insoluble substance) when treated with a mixture of anhydrous nitric acid and potassium chlorate. Ordinary carbon is dissolved by these reagents. The coating on the treated filament has also the greasy feeling of graphite, and gives the characteristic mark of graphite on white paper.

After being heated to high temperatures in the electric resistance furnace, these characteristics continue and the chemical action is much more marked. Metallised filaments blacken the lamp bulb very much less than ordinary filaments. This may be due to the removal from the former of practically all the mineral ash and other impurities, or it may be due to the changed character of the carbon itself.

Bamboo, coated by dipping in a solution of asphalt, is altered by firing, the coating changing to graphite and giving the characteristic positive curve. Silk, dipped in a sugar solution, also gives the same result. The base of a metallised filament, from which the treated coating has been removed, when mounted in a lamp has been found to give the resistance curve of a fired base. Pieces of the coating, about 1.5in. long, mounted in lamps, have been found to give the strongly positive resistance curve that is characteristic of the metallised filament. These observations show that the change is practically all in the treated coating and not in the base.

Metallised filaments, as above described, are much more stable at high temperatures than ordinary carbon filaments. The most effective carbon filament lamp now in general use operates at 3.1 watts per candle, and under accurate test conditions gives a useful life (to 80 per cent. of its initial candle-power) of about 500 hours. At the present time metallised filaments that give the same useful life at about 2.5 watts per candle are being produced with a fair degree of uniformity.

Potential Regulation Based on the Different Resistance Behaviour of Carbon and Tantalum Lamps.

By A. E. KENNELLY and S. E. WHITING.

THE marked difference between behaviour of carbon and tantalum incandescent lamps at different voltages has suggested to us the possibility of employing this property for the operation of a relay capable of controlling, by its secondary actions, the voltage of a circuit.

It is well known that the resistance of a carbon filament incandescent lamp falls very markedly as the current through it increases. Thus, a 120 volt 16c.p. carbon lamp, which has a resistance of 600 ohms when cold, will have a resistance of about 300 ohms when at normal incandescent voltage. A 110 volt tantalum lamp, on the other hand,* which has a resistance of 50 ohms

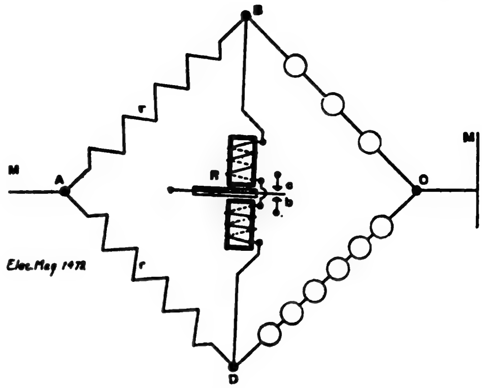


Fig 1.

when cold, may have a resistance of 300 ohms when at normal incandescent voltage. In each case the most rapid change of resistance takes place in the initial stages of voltage and current application. Between half voltage and full voltage the changes in resistance are relatively small. If, therefore, a Wheatstone bridge arrangement, A B C D, Fig. 1, be made up between a pair of mains, M M, with two branches, *r*, *r*, of similar resistance, the branch B C, with carbon filament incandescent lamps, and the branch D C, with tantalum filament incandescent lamps, a polarised relay or equivalent magnetic mechanism, R, can be made to respond to variations in the line voltage between the mains M M. All of the incandescent lamps will be operated at much below their normal voltage, and the resistance of the lamps will therefore be in a state sensitive to changes of voltage. If, for instance, a bridge balance is secured at a voltage $e = 115$ volts, then if the voltage should rise, say, to 116, the carbon filament branch of the bridge will diminish in resistance, while the tantalum filament branch will increase in resistance. This dissymmetry will destroy the balance and send a current through the relay from D to B, tending to throw the tongue of the relay against the contact stop, *c*. If, on the contrary, the main voltage should fall, the carbon resistance would increase and the tantalum resistance decrease, upsetting the balance in the opposite sense and sending a current through the relay from B to D. This current would tend to throw the tongue of the relay against the contact stop, *b*. Under these conditions the relay would be capable of operating apparatus through its local circuits

* "Some Tests of Tantalum Lamps," by A. E. Kennelly and S. E. Whiting, *Electrical World and Engineer*, March 25th, 1905.

in some of the various known ways for regulating the main voltage.

The bridge connections of Fig. 1 are naturally capable of being modified in a variety of ways in order to attain the same result. Thus either the carbon lamps or the tantalum lamps may be removed and replaced by an invariable resistance of metallic wire. This plan should be less sensitive, since the bridge would possess but a single resistance-varying arm. Again, all four arms of the bridge might be made of variable resistance, both A D and B C being occupied by carbon lamps, while both A B and C D would be occupied by tantalum lamps. This plan should be a more sensitive arrangement.

An alternative plan to the use of the Wheatstone bridge is offered by the use of a differentially wound polarised relay, as indicated in Fig. 2. R is a differential polarised relay. The circuit from the mains, M M, splits through the coils of this relay, passing on one side through the carbon filament

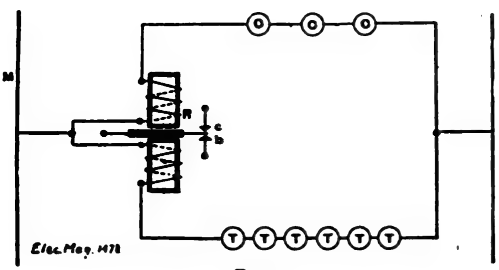


Fig. 2.

lamps, C C C, and on the other side through the tantalum filament lamps, T T T. The lamps are so chosen, or the resistances of their respective paths so adjusted, that the two branch currents have equal strength at normal voltage between the mains, thus leaving the relay in balanced condition, *i. e.*, with zero excitation. If now the main voltage should rise, the resistance of the carbon branch will diminish and that of the tantalum branch will increase, thereby upsetting the balance in favour of the carbon branch current, and urging the tongue of the relay against the stop, *c*. On the contrary, if the main voltage should fall, the differential balance would be upset in the opposite direction and the tongue of the relay urged against the opposite stop. This action of the relay might likewise be invoked to control the main voltage through mechanism actuated by local circuits from the relay.

In order to test the arrangement of Fig. 2 the authors employed a differential Western Union polarised relay, such as is used in the polar duplex system. The resistance of each of the two relay coils was approximately 423 ohms at the working temperature. The armature of the relay was a steel tube 0.379in. (0.963cm.) in diameter. The play of the tongue between the stops was 0.0015in. (0.038mm.), and the clearance or air gap between the armature tube and the poles was 0.06in. (1.5 mm.) on each side. Three carbon filament 120 volts 16c.p. lamps were employed on one side at C C C, and six 110 volt 25 hefner tantalum filament lamps were employed on the other side at T T T. This arrangement secured a current strength of 84 milliamperes in each branch, or a differential balance, at the main voltage, of 120.4 volts. The drop in each relay coil being 35.5 volts, the remainder, or 84.9 volts, was impressed upon each set of lamps, representing 28.3 volts per lamp in the carbon series, and 14.15 volts per lamp in the tantalum series. Under these conditions, the resistance offered by each carbon lamp averaged 336 ohms, and that offered by each tantalum lamp 168 ohms.

It was found that, under laboratory conditions, when the relay was carefully adjusted, an increase in main voltage of 0.6 volt (120.4 to 121 volts) would cause the relay to throw over its tongue in one direction, and a fall of 0.6 volt, or back again to 120.4 volts, would cause the relay to throw its tongue back against the original stop. Consequently the relay was found to be capable of operating continuously on a voltage variation of ½ of 1 per cent. The movement of the relay followed the change in voltage after a time lag of about one second. This time lag appeared to be of thermal origin and to be attributable to the action of the lamps. It seems likely that with a relay specially designed for this work, a still greater degree of sensitiveness could be obtained. The article concluded with an outline of the engineering theory of the apparatus.—*Electrical World.*

A New System of Street Lighting.

BRITISH engineers know what it is to operate arc lamps from alternate current circuits by means of rectifiers, of the Ferranti commutator type more especially. When these devices were introduced, they had considerable vogue as the quality of light emitted by a rectified current arc was infinitely superior to the craterless flicker of ordinary open alternate current arcs. The use of revolving devices, especially when operated by synchronous motors, is, however, to be deprecated, and when similar results can be obtained without their aid, they should be abandoned for the simpler stationary apparatus. Publicity has recently been given to an arc lighting system employing the mercury vapour rectifier as the "changing medium between the lamps and the generators."

The following details, taken from an American contemporary, describe generally the system adopted:

Briefly described, the feature of the system is the operation of direct current arc lamps, of either the carbon or luminous arc type, from an alternating current supply by means of a constant current transformer and a mercury arc rectifier, thus obtaining both the excellent light of the direct current lamps and the perfect regulation of the constant current transformer, through the medium of a reliable, efficient and simple piece of apparatus.

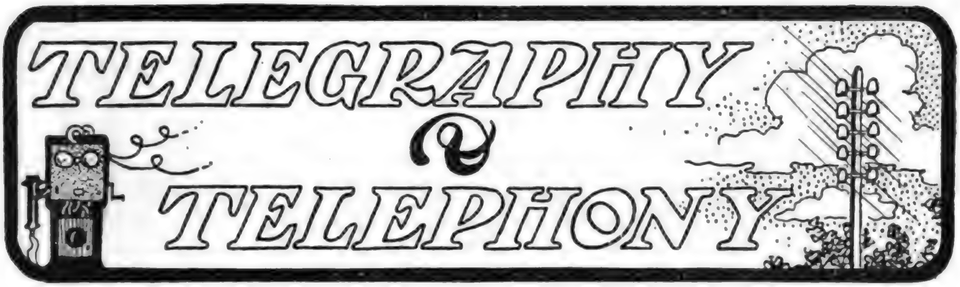
The remarkable properties of the mercury arc rectifier for low-voltage applications are now well known through the recent introduction of the battery-charging rectifier panels. Therefore, no theoretical discussion of the rectifier tubes will be attempted. A few changes in shape from the form of the low-voltage tubes have been found advisable, and a few additional precautions are taken in manufacture, on account of the high voltage to which the tubes are subjected when operating series street lighting circuits. Naturally, difficulties have been met in handling high voltages, but they have not proved insurmountable, and to-day 25,000 volts are handled with the rectifier much more easily than one-hundredth of this voltage was controlled only a few years ago.

The transformer used to supply the lighting circuit through the rectifier is of the well-known constant current type, air cooled except in the largest sizes, where, on account of high voltage, oil cooling is preferable. It differs from the standard type only in that it requires a specially wound secondary, having a smaller section of wire and greater number of turns than is usually employed. These special secondaries are usually wound in two coils, thus giving a convenient neutral point to which the negative terminal of the load is connected.

The first commercial installation of luminous arc lamps operated from a rectifier was made by the Schenectady Illuminating Company in March, 1905. The lamps are placed on Dock Street, Lyon Street, and Edison Avenue, and have been operated from the rectifier without the slightest trouble or interruption since that time, thus confirming the results of earlier tests, that the system is efficient and reliable.

The rectifier is mounted on a pivoted support on the front of the arc light controlling panel. A modification of this arrangement adopted in later sets has been to mount the rectifier on a small marble base and to mount this base above and back from that part of the panel on which the operating switches are located. This arrangement entirely avoids the presence of high-potential terminals on the front of the panel. A small transformer supplies low-voltage alternating current to a pair of auxiliary starting anodes; consequently, the rectifier may be started before any of the high-tension plugs are thrown in. After starting the rectifier it is necessary only to plug in the circuit and transformer plug switches, starting as though the system were series alternating.

The efficiency of the rectifier system is practically the same as that of the constant current series alternating arc light system, since at the high voltages used the loss in the rectifier becomes almost negligible. In light efficiency, however, the rectifier luminous arc system shows a marked advantage, on account of the great increase of light given by the luminous arc lamp at approximately three-quarters the energy. Although the same increase of light, due to the use of the magnetic arc lamp, may be obtained from a motor-driven arc light dynamo, there can be no comparison between this method of operation and the rectifier, either in efficiency of the system, amount of apparatus, or ease of operation.



For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

Telefunken System of Wireless Telegraphy.

THE "Telefunken" system of wireless telegraphy arose out of the amalgamation of two systems which had separately obtained a world-wide renown among the many competitors in the field of spark telegraphy. These were known respectively as the "Braun-Siemens" and "Slaby-Arco," the one being exploited by the Gesellschaft für drahtlose Telegraphie Prof. Braun und Siemens und Halske, and the other by the Allgemeine Electricitätsgesellschaft. In the summer of 1903 the two systems were fused into one, and the simple name "Telefunken" selected as the title of the combined systems. The apparatus employed is made from models in the workshops of the two electric companies already mentioned ; so that, both in workmanship and material, the articles produced maintain the high standard of excellence which characterises all the manufactures of these companies.

For experiments with aërial conductors six special stations are in use in and around Berlin, where the carrying distance and syntonising of all new arrangements can be immediately tested, measurements taken of the lengths and intensities of waves, and observations made with regard to the phenomena of damping. By this means long distance trials are rendered almost absolutely unnecessary.

Amongst the principal patents owned by the company we may mention as an example the transmitter arrangement in which an oscillation circuit consisting of Leyden jars and a spark gap, and containing large amounts of energy, excites the aërial conductor to slightly damped self oscillations. Protection in Germany for this device was obtained ("on principle") in the year 1898, that is, two years before the Marconi Company in England began to employ the same arrangement. A similar device for the receiver was patented January 1st, 1901. It consists of a closed resonance oscillating circuit which, by a clear and pronounced self-period, renders the receiving system sensitive to a definite transmitter frequency only, and thus easily eliminates disturbances emanating from foreign transmitters; while the receiving system becomes adapted for taking up the whole energy radiating from the transmitter with jar excitation.

Mention may also be made here of the loose coupling of receivers. Owing to Wien's well-known publications in the "Annalen der Physik," any general patent on this contrivance could not be obtained, but a number of special parts were patented, by the employment of which it becomes possible to syntonise with great accuracy without any loss of intensity or reduction of distance. Finally, a patented electrolytic wave detector is employed which is claimed to be the simplest and most reliable receiver yet produced.

The following description of apparatus and accessory parts is taken from the official pamphlet of the company :

For mechanical stability phosphor bronze wire is used for the aërial conductors of fixed stations. The insulation of the wires at the upper extremity is effected by insulators

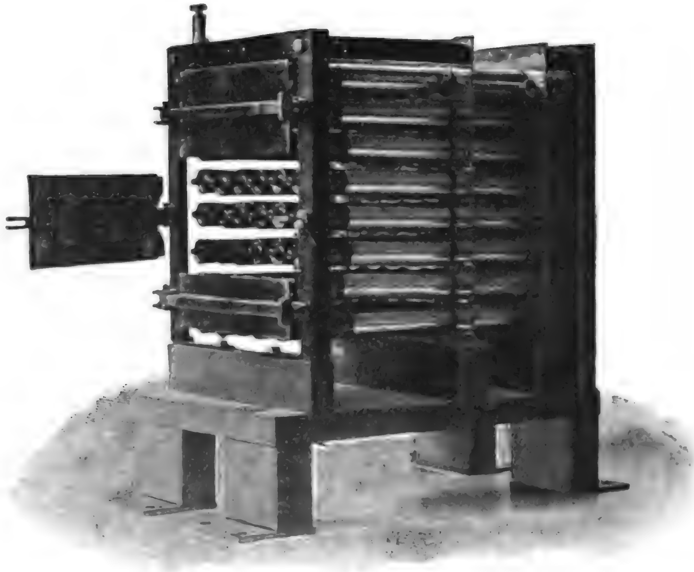


FIG. 1. SPECIAL EXCITATION CIRCUIT.

made especially for this purpose. Owing to their extensive creeping surface, ebonite rods have not proved successful in air charged with moisture. Every aërial conductor is earthed directly by means of a lightning-switch during thunderstorms, and thus also serves as a lightning conductor for the mast.

For stations with a guaranteed maximum range of 150km. inductors with hammer interrupters are exclusively employed. The primary condenser for avoiding the opening spark at the hammer is enclosed in a separate case.

For primary energies up to 350 watts, hammer interrupters are employed, in which a maximum tension of 110 volts continuous current is permissible. For from 350 watts to 1.5kw. either turbine interrupters or current changers are used, the latter being direct transformers, or pairs of machines, which consist of one continuous current

FIG. 2. ORDINARY RECEIVER WITH GRANULAR COHERER.

motor and one alternator. This latter construction is only made to order, on account of its necessitating a special insulation of the main dynamo. In portable stations a benzine motor drives, either direct or by belt, an alternating current dynamo.

The keys are either equipped with electromagnetic spark extinguishers or constructed as automatic minimum current cut-outs. In large stations having current intensities of more than forty amperes several platinum contacts are connected in multiple. The exciting circuits for coupled senders consist of (*a*) one "multiplex" discharger with generally three spark gaps, (*b*) the Leyden jar battery, and (*c*) a self-inductor, generally variable. Fig. 1 illustrates a circuit of excitation for portable stations with which, by changing the plugs, two different waves may be created. The mounting is direct. To all circuits of excitation is attached a switching discharger, by means of which the circuit of excitation is separated from the aërial conductor while messages are being received.

The ordinary receiving apparatus with granular coherer is illustrated in Fig. 2. Besides this latest type, there is in use another series of different construction, among which is the receiving apparatus model FK (Fig. 3), especially constructed for portable stations, this being particularly light and small.

The receiver relays are always equilibrated and polarised, and only leave the workshops after having been tested at 1.4 volts pressure in a circuit containing a resistance of 100,000 ohms. Special attention is paid to a fine adjustment exempt from "dead" movement, as well as to the insulation of the relays against the mechanical vibration of the tapper. The different parts of the tapping device are of small dimensions, and the number of vibrations is very great.

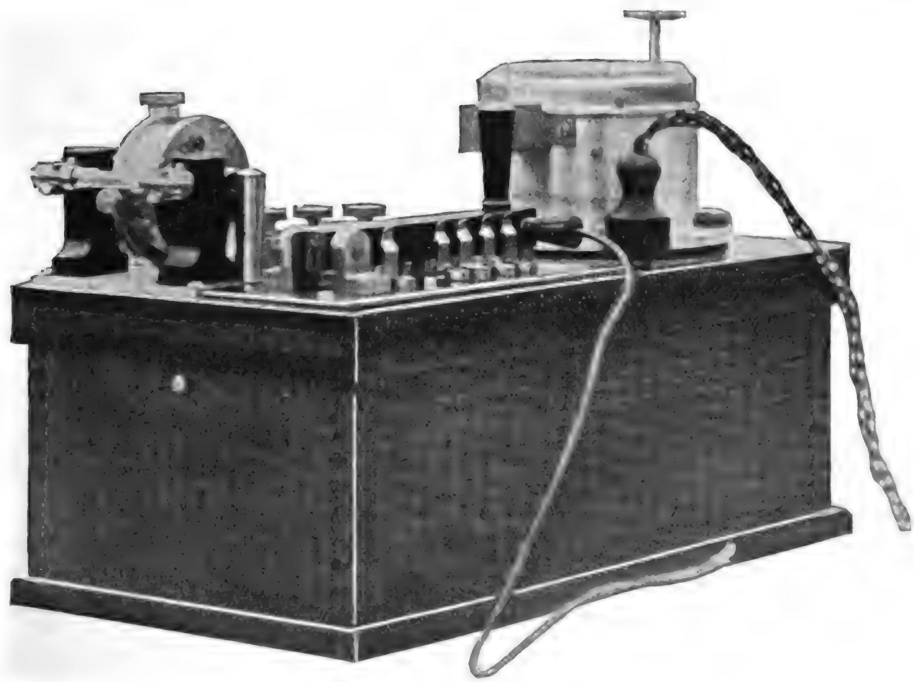


Fig. 3. Model FK. Receiver for Portable Stations.

In the construction of all apparatus delicate and sensitive parts are, as far as possible, avoided. A main switch on the receiving apparatus serves to change from receiver to transmitter, cutting out all local circuits at the receiving station or blocking the primary current at the transmitter.

By using polarisation batteries and various ohmic resistances, sparking at the relay or the tapper is completely avoided.

The only coherer used is a patented vacuum coherer with V-cut, and adjustable

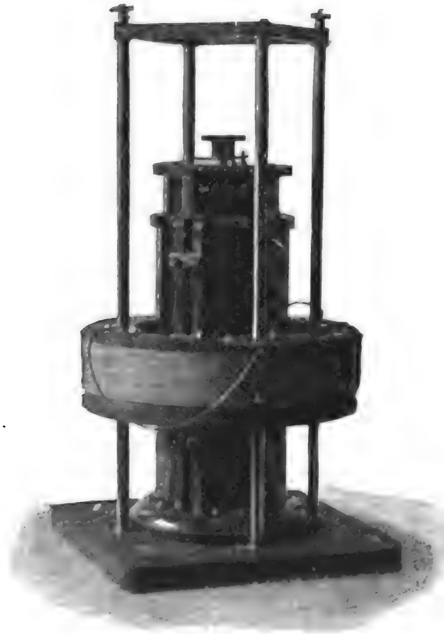


Fig. 4. Receiver Transformer, with Adjustable Slider.

sensibility—one for short distances and the other for long distances. It was found necessary to definitely choose this form of coherer, because it was the only one which possessed the constancy and permanence essential for practical working. Its construction is such as to permit of its being replaced by another in a few seconds. This exchange requires no sort of alteration in the receiving apparatus.

For ships the whole receiving apparatus—including Morse printer—is fitted with easy springs to preserve it against the vibration of the engines.

For receiving apparatus described above, with close coupling, transformers consisting of a single coil are used, and any desired number of windings may be used by adjusting sliders (Fig. 4). Three standard sizes are made. The smallest includes a wave-range of 50 to 200 mètres; the middle (standard type for warships) ranges from 200 to 600 mètres; the largest from 600 to 3,000 mètres.

This construction is distinguished by its simplicity and the ease with which the wave-length may be varied.

Besides the ordinary receiving apparatus with coherer and Morse printer, an electrolytic receiver with telephone hearer is supplied. The electrolytic hearer is now the simplest and most reliable receiver for spark telegraphy. For larger stations a reserve hearer is generally supplied to be used in place of the normal Morse printer during disturbance.

(*Through lack of space Mr. Walter's concluding instalment is again held over.*)

*Standard Toll Signs.**

By W. F. LAUBACH.

There is perhaps no department of the independent telephone business so generally neglected as that of advertising; it is perhaps also true that it is the only feature which may to a certain extent be ignored without as disastrous results as the neglect of any detail in connection with the operation proper. Every enterprising, progressive, and —shall I say?—successful business man of the present day knows he must exploit his wares if he expects to sell. Advertising has become a distinctive business, and so varied are the ways and means employed that it has become one of the important departments of every well-appointed business establishment.

Millions of dollars are wasted annually upon injudicious advertising. Many more millions also are judiciously expended or invested, not for merchandise direct, but for purposes of informing the prospective purchaser where he may find the article he is in search of--evermore; an attractive and well-worded "ad" will positively create a demand on the part of the public, who, without knowing, are silently "led to the slaughter." The "ad" has done its work, and has done it well. This fact, no doubt, explains how many a man is enticed into a personal interview with "what made Milwaukee famous." The "ad" often seen has finally aroused a desire for closer communion.

It is not idle assumption that advertising is one of the fundamentals of success in these days of hustle and fierce competition. The vital question is: How shall advertising be done? Some, in defining what is meant by General Publicity, say it is keeping the *name* constantly before the *people*. Now that is exactly what we independent telephone operators must aim to do. The *name* which we want to keep before the *people* already

* Paper read at the National-Interstate Independent Telephone Association Convention, Chicago.

has been decided upon and accepted by us. The *name* is "Independent." This name can be silently and forcibly expressed by some design, so that not only the term "Independent," but for us its complement also, the word "Telephone," will be associated therewith instinctively when a certain design is flashed upon the vision. "Independent Telephones" is what we want to get before the people, and keep before them.

To illustrate my meaning—who does not instinctively think of a breakfast food known as "Quaker Oats" when his eyes behold the rather quaintly but characteristically dressed figure representing the Quaker? Who does not instinctively associate with a picture of that huge mass, the rock of Gibraltar, this familiar sentence: "The Prudential has the strength of Gibraltar"? So impressive is this unique trade-mark that one would almost feel inclined to look for the very letters, somewhere back of the fortifications, while gazing upon the actual and natural scenery itself.

These are instances of trade marks or successful advertisements which are before the people as irrepressibly as the very earth upon which they tread. Until we have impressed this fact indelibly upon the public mind, we shall not have accomplished what is necessary to our greatest achievement; nor will any individual company possess the prestige it will otherwise command. How shall this education be best conducted? The answer seems simple enough—*advertise*. The question then arises, What is the most impressive mode of advertising? It is generally conceded that that which appeals strongest to the sense of sight, by which an impression is conveyed to the store-house of the mind, leaves the most abiding impress. If this is true, and experience teaches it to be so, we cannot go wrong by adopting some simple and dignified emblem that will at once appeal to the eye. Among this class of emblems there is none more pleasing, impressive, comprehensible, and effective than the shield; peculiarly so when emblazoned with the tricolors of our national design. The particular trade mark or standard sign which I trust this convention may see fit to adopt by a unanimous resolution is the one with the shield in the national colours, red, white, and blue, within a white circle surrounded by a solid blue field. This will not only make a graceful, artistic, and impressive sign, but at the same time a fitting emblem for independent telephony, in its *rôle* of defender of the public against the extortions of monopoly. If this convention should see fit to recommend the universal adoption and generous display by each independent operating company throughout the United States of a uniform trade mark such as this sign would be, it will have accomplished a vast work, and one which will, if put into general practice, do more to eliminate that certain ignorance on the part of the public which now exists and works against our interests. I refer to that ignorance or belief on the part of the general public that the average local company is merely local, and for that reason cannot furnish so-called long-distance service.

Do I hear some interested investor or manager say, "We are jealous of our individuality, and do not care to adopt measures which may jeopardise our local standing"? To such let me recall the ancient motto, "United we stand, divided we fall." The more the spirit of unity is cultivated and carried into execution, the more we shall all reap the fruits of gigantic enterprises. It has been demonstrated times without number that had it not been for the larger "Independent" companies, acting as a strong arm about the smaller and weaker ones, they would have been frightened into selling out at great loss, or have become sub-licensees of the Bell bugaboo.

Telephone Troubles and How to Find Them.

As a telephone line is exposed to the weather and the elements, it sometimes happens from the very nature of things that "trouble" will be encountered. In such cases no technical skill or technical education is necessary to remedy the difficulty, but a certain degree of common sense is required to observe how the line or instruments act, and from such observation locate the cause of the trouble. Once located, the remedy can be applied.

The action of a telephone on a bridging line is in accord with certain great but simple laws of Nature. Therefore, the following few and simple rules will be found to cover, not only the most likely source of trouble, but, far more than that, will offer a solution for

nearly every possible problem that could present itself in a disordered telephone circuit:

If a telephone can be called, but cannot call others, look for: (1) Poor ground connection; (2) weak or defective generator; (3) ringer movements of different resistance on same line.

If a telephone cannot be called, but can call others, look for: (1) Imperfect gong adjustment; (2) ringer movements of different resistance on same line; (3) defective ringer movement (striker); (4) short-circuit through automatic cut-in.

If a message can be received, but not transmitted, look for: (1) Exhausted batteries; (2) batteries improperly charged or connected; (3) broken wire in battery circuit; (4) damaged transmitter.

If message can be transmitted, but not received, look for: (1) Short circuit in receiver; (2) defective adjustment in receiver.

If a telephone will talk, but will not ring, look for: (1) Line trouble; partial short circuit. Detaching line wires should leave the telephone so it will ring its own bell.

If incoming signals and messages are weak, look for: Poor ground connections.

If the voice makes any breaks when talking, look for: A loose connection.

All joints of every kind should be carefully soldered to prevent such trouble and to insure continued good service.

When a telephone does not receive a ring as loudly as is desired, but performs all other functions satisfactorily, the trouble may be nearly always looked for in the adjustment of the gongs. When a telephone is tested at the factory before being shipped, the adjustment is made so that it will receive a ring on the most heavily loaded lines. If, when the telephone is installed, it is placed on a line which is not so heavily loaded, the clapper will hit the gongs so heavily as to make a dead sound. By moving the gongs wider apart a louder and clearer ring will be secured. If, in adjusting the gongs wider apart, however, the clapper shows a tendency to cling to one of the gongs, the remedy will be found in the previous paragraph.—*Telephone Magazine.*

Telephone Tuition.

A FOUR years' course in telephone engineering has been introduced during the past year in the Armour Institute of Technology. The introduction of this course resulted from the demands of the telephone manufacturers and operators for technically trained men. Each year the graduating class has been drawn upon for men trained along telephone lines, and in order to supply this demand, which has been constantly increasing, the authorities of the Institute decided to introduce a special course in which the young engineer would be especially trained in problems relating to telephone engineering. During the past year several of the young men availed themselves of this opportunity and took up the course with great enthusiasm. As a result these students are now employed during the vacation period among the various telephone interests about the city. Several of the men are night managers in the Bell exchanges, many of them are employed in the several departments of this large company, while others have found employment with the Independent manufacturing interests. The manufacturers find that the students are particularly valuable in their engineering departments. They prove to be excellent draughtsmen, rapid, accurate, and skilful computers and designers. The operating companies find that the men work with more interest and enthusiasm than the ordinary telephone employé, and also that the student is ready to apply whatever technical knowledge he may have gained to the solution of the problems placed before him. Indications are that next year's classes will be very large, and many large operating companies have already placed applications for graduates. The special courses in telephony are taken up at the beginning of the second year. The two previous years are spent in studying elementary subjects such as are required in all of the engineering courses. Mathematics and physics form the major portion of these studies, as it is essential that the young engineer should be highly trained in these principles. At the beginning of the third year a diversion is made in which the student is required to make a detailed study of the elementary principles of telephone engineering. The first course consists of a complete study of simple telephone apparatus, circuit diagrams, and switchboard work. Lecture and laboratory work acquaint the student with the details of various apparatus as manufactured by the Bell and Independent companies. Transmitters, receivers, batteries, ringers, and other apparatus appertaining to the subscribers' substation are thoroughly studied. The theory and practice of various systems is worked out and the student is expected to draw various circuits and diagrams illustrative of the best engineering practice.

Considerable work in power engineering is required for graduation. A thesis upon some line telephone problem is taken up during the fourth year, acquainting students with actual problems of the day.—*Sound Waves.*

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

*A Chat about Accumulators.**

By S. R. BOTTONE.

Now that gas and oil engines enter so largely into the details of our daily life, either for supplying power for domestic or manufacturing purposes, or for ministering to our pleasure by driving our automobiles on land or on water, a little consideration of certain accessories that contribute largely to the successful working of these internal combustion engines is fraught with much interest to all those who, having occasion to make use of them, desire to form an intelligent conception of their mode of action. Among these accessories the *accumulator* holds an important place, both as regards its present value as being perhaps the most convenient device whereby the electrical energy required to produce the spark necessary to fire the explosive mixture can be stored or liberated, and as its probable use in the near future (when its excessive weight shall have been reduced) as a convenient recipient of the energy destined to drive our automobiles, &c., through an electro-motor, without the intervention of the noisy and malodorous petrol motor. We propose, therefore, to devote a few pages to the consideration of the laws that govern the construction and action of a good accumulator.

1. We will first attempt to define what an accumulator really is. An accumulator is an arrangement by means of which we are able to decompose water (that is to say, to split it up into its two constituent elements, *hydrogen* and *oxygen*) by the application of *energy;* the form of energy usually (though not necessarily) employed being electricity. Then, when the decomposition has been carried to the required point, the two gases are allowed to re-combine to re-form water, when the energy which had been absorbed in effecting the decomposition is liberated in the form of electricity. This effect may be likened somewhat to a helical spring, which requires the application of some mechanical energy to stretch it, or draw its convolutions farther apart, but which will restore most of the energy required to effect this extension on being released and allowed to regain its original dimensions by the removal of the straining force. To facilitate the comprehension of this view of our subject, the reader will do well to bear in mind that all elements in their free or uncombined state are endowed with certain specific amounts of energy; and that when any one element combines with another, that energy is liberated in the form of heat, light, electricity, or otherwise. On the other hand, if it be desired to separate the constituent elements of any compound body, energy in some form must be supplied in order to replace that liberated during combination. Hence during the decomposition of water a true strain must be exerted to supply the required energy; it may be in the form of heat, as when we decompose water by passing it in the form of steam through a white hot porcelain tube, by which treatment it is resolved into its constituent gases, which take up, in the act, the required amount of energy; or it may be in the form of electricity, as in the case of sending a current thereof through the water, which brings about the same result by furnishing the necessary energy in the form of electricity.

2. As a matter of fact, the very first notion of what we now term an accumulator was due to observations made by Gautherot,

Ritter, and others, who noticed that the platinum (or silver) wires which had been used for the decomposition of water became themselves capable of giving an electric current. In 1842 Grove constructed his gas battery, which, though no longer used except for scientific demonstration, illustrates so perfectly the principle on which the modern accumulator depends, that our sketch Fig. 1 will prove of interest. In this we have two glass tubes, A B, into which are inserted two stout wires or narrow strips of platinum, P P. These are sealed into the glass tubes at their upper extremities, but are in metallic communication with the terminals T T′. The lower or open ends of these tubes are arranged (when the battery is to be used) so as to admit of being plunged into a vessel containing water, usually slightly acidulated to increase its conductivity. If now these tubes be partially filled, the one, A, with oxygen and the other, B, with hydrogen gas, no apparent result will follow; but if the terminals T T′ be joined together by a wire, or any other conductor of electricity, two phenomena will be noticed, the first being that the volume of the gases in the two tubes will diminish, that in A at half the rate of that in B, the water rising at the same time to occupy the space; so that if the tube B originally contained twice the volume of hydrogen gas as the tube A contained of oxygen, if the experiment were carried to a

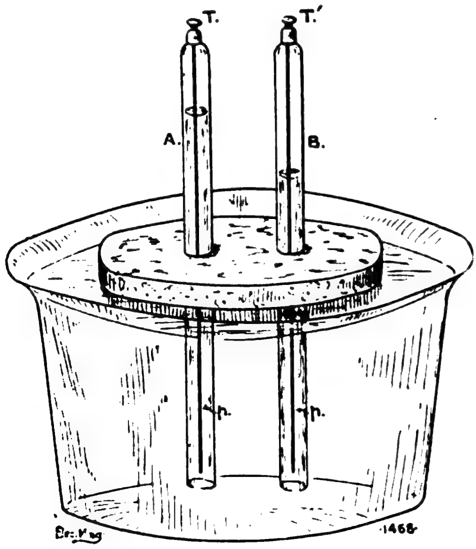


Fig. 1. Grove Gas Battery.

conclusion, both gases would have disappeared at the same time. The second noticeable result is that while the gases were re-combining to form *water*, a current of electricity would be flowing from the terminals T to T′ along the wire, or other conductor, by which they were joined. It is indifferent to the success of this experiment whether the two gases with which the tubes are to be supplied be prepared by chemical means, and led into the tubes from below from retorts, gas bottles, &c., or whether they be obtained from the water (with which the tubes should, in this case, have been previously filled) by means of an electric current passed through it, by connecting the positive pole of a battery to T and the negative thereof to T′. In Groves' original experiment, this latter was the method adopted. We learn from this that the two essential points to obtain this result are, firstly: that we should in some manner be able to prepare these gases in a free state by charging them with energy, and secondly, that to enable them to re-combine, and avail ourselves of the energy simultaneously set free, we should place them, by means of a conductor, in electrical connection the one with the other. It is by no means essential that we should employ platinum as the metal by means of which the two gases are either separated or allowed to re-combine; fortunately cheaper metals, notably lead, can be substituted with results that are even better.

3. The first really practical accumulator was that devised by Gaston Planté in 1859, which consisted essentially in two sheets of lead, each about 1ft. wide, 6ft. long, and $\frac{1}{16}$in. in thickness, which were laid one upon the other, but prevented from coming into actual contact by means of long strips of india-rubber or stout felt, and then rolled round a cylinder of wood, so as to form a compound spiral, as shown in Fig. 2, where it is depicted as it appears when plunged into a glass jar containing dilute sulphuric acid. Each sheet is connected to a separate terminal, by means of which either a current of electricity can be caused to pass through the acidulated water, thus effecting its decomposition, or a current drawn off when the decomposition has been effected. The Planté accumulator embodies all the essentials of our modern "storage cell"; but it labours under several disadvantages which have been overcome more by modifications in the form and treatment of the original lead sheets than in any

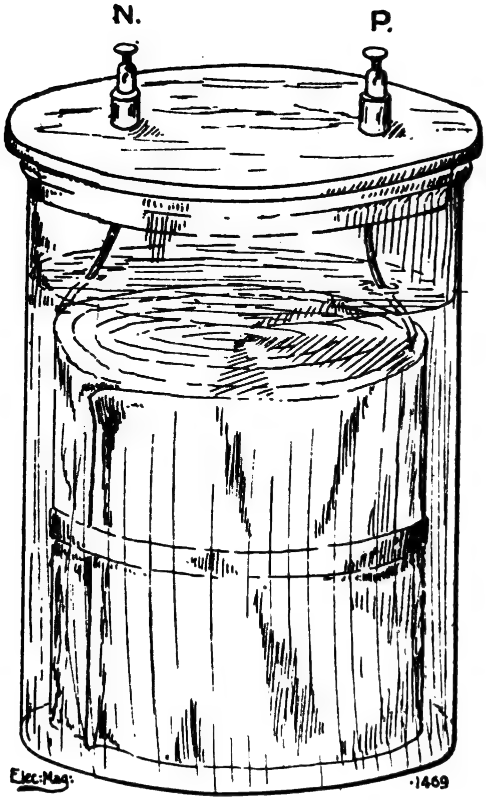


FIG. 2. SIMPLE PLANTÉ CELL.

radical change in principle imported into the more recent types.

4. We may therefore stop to consider what takes place when such an accumulator, duly charged with acidulated water, is subjected to the action of a battery (or other source of electricity) having sufficient electromotive force (usually abbreviated E.M.F.) to tear asunder the molecules of hydrogen and oxygen which go to form water. The first thing that strikes the observer's attention is that an E.M.F. of about 2.5 volt (the volt is the accepted unit measure of electrical pressure) is required to effect the decomposition of water, or, to speak more accurately, of the acidulated water contained in the accumulator cell. When this condition is satisfied it is found that on connecting up the two terminals, N. P., of the cell, one to the negative and the other to the positive electrode of the source of electricity, decomposition immediately commences, as evidenced by the extrication of minute bubbles of hydrogen gas from that sheet or plate which is connected to the negative electrode.

(*To be concluded.*)

Electro-Chemistry in Germany.

(Reports of Papers read at the Eleventh Annual Meeting of the Bunsen Gesellschaft.)

By JOHN B. C. KERSHAW, F.I.C.

(*Concluded from p. 35.*)

Notes on Ozone. Professor Luther (Leipzig).

OZONE as an oxidising agent, in most oxidation processes, works as a divalent molecule, since only one-third of the oxygen present in the molecule of ozone takes part in the chemical reaction. Should, however, the product of this reaction be acted upon by gaseous oxygen, further oxidation occurs, and all of the oxygen atoms present in the ozone molecule take part in the reaction, which becomes hexavalent in character. In acid solutions, the valency of the ozone molecule shows another change.

This value is therefore variable, and it can be best determined by means of Heroult's formula and method. This depends upon measuring the P.D. of the ozone solution at various degrees of concentration, using electrodes not acted upon by the electrolyte. Should the ozone be acting with one-third of its oxygen, the P D. alters .058 volt, when the concentration is varied 10 per cent. When two atoms of oxygen enter into the reaction, the P.D. varies $\frac{.058}{r}$, or .029 volt. In order to determine the concentration of the ozone solution, $FeSO_4$ was employed, the excess of this being estimated by means of titration with $KMnO_4$ solution. In such a solution, the P.D. measured with platinum electrodes was .054 volt; the reaction was therefore with one atom or molecule of oxygen. Although this result is surprising, the author holds that Grafenberg is wrong in considering that the ozone molecule acts as a hexad in such a solution, and that all six of its valencies are engaged in the reaction. Grafenberg's theory that ozone, in the gaseous form, possesses a higher reaction valency than when dissolved, was also disproved by the author, who showed that this would involve a contradiction of Henry's law regarding the solution pressure of dissolved gases, and direct experiment proved that no such contradiction occurred.

Experiments carried out with iridium electrodes in place of platinum also confirmed the correctness of the author's view.

The equation given below therefore

represents the usual change when ozone is used as an oxidising agent :

1. $O_3 + 2\ominus = O_2 + O$

or 2. $O_3 + 2\ominus + 2H^{\cdot} = O_2 + H_2O.$

It is perhaps allowable to assume that ozone exists in an active and passive state like chromium, and that in the former it acts as a dyad, and in the latter as a hexad, in chemical reactions. This would render the valency dependent upon the reaction, not upon the agent used. Nernst has raised as an objection to the application of his method for determining the valency of the reaction in this particular case, that the production of oxygen at one electrode may influence the results observed. The author points out that this objection is not supported by the experimental results, for the P.D. variation is always .058, or .029 volt, and no intermediate values have been observed. Professors Haber and Nernst joined in the discussion of this paper, and referred especially to the P.D. of the oxygen and hydrogen gas cell, which Nernst gave as equal to 1.2207 volts.

The Formation of Magnetic Compounds from Diamagnetic Elements.—Dr. E. Wedekind (Tübingen).

The author has recently prepared compounds of manganese and boron by aid of the Goldschmidt aluminium reduction process. Compounds having the composition MnB_1 and MnB_2 were prepared by this method, and both were magnetic. The crystalline product was powdery and could not be melted, so its magnetic properties were determined by comparison with those of powdered iron. The magnetic saturation curve was studied up to a field strength of 1,100 to 1,300 units.

The highest point of the curve for manganese boride lay about one-half of the height of that for iron ; while the magnetic saturation point was attained in the first case with 1,200 units, and in the second with 650 units.

Manganese arsenide is diamagnetic, while an alloy of manganese and bismuth is magnetic, although bismuth is strongly diamagnetic. The author gives as proof that these combinations are not mere alloys the fact that by treatment with chlorine gas the excess of either component can be removed without causing decomposition of the whole. They are also non-conductors of electricity. If one fills a glass tube with any of these powders, and then magnetises its contents, and hangs the tube by a thread from its centre, it will assume a north and south line; by shaking it, however, the magnetic charge is dispersed.

The Electro-Chemical Equivalent, and the Electrical Conductivity of Metals. Dr. M. Reiganum.

The author has traced a connection between Faraday's law and the electrical and heat conductivity of the metals.

Taking e as the electrical charge, u as the mean molecular speed, m as the mass of the particles which carry the current, T as the absolute temperature, K as the heat conductivity coefficient, and P as the electrical conductivity, the equation

$$\frac{K}{P} = \frac{1}{2}\left(\frac{mu^2}{e}\right)\frac{1}{T}$$

is obtained. This equation expresses the law discovered by Wiedemann and Frantz. The portion of the expression within brackets can be calculated out for electrolytes. It will be found that basing the calculation on the value $\frac{K}{P}$ for metals, the value obtained for $\frac{mu^2}{e}$ is exactly the same as that for electrolytes. The proportion between active force and charge is the same in the case of the metallic conductor as in the fluid state and is that of a single charged ion. In other words, if the active force be similar in the two cases, the charge of the metal carrier will be exactly that of a single ion.

The equation given above is made up of the two separate equations for electrical and heat conduction :

$$P = \frac{1}{2}\,\frac{l}{u}\,\frac{e^2N}{m}$$

$$\text{and } K = \frac{1}{6}\,\frac{lm}{T}\,Nu^3$$

in which N = the number of conducting ions per unit of volume.

By the aid of the first equation one can calculate the number of charges per atom.

An illustration of this method of calculation in the case of copper was finally given. Thus $\frac{Ne^2}{m}$ equals 7.10^9 units. If one takes for $\frac{e}{m}$ the value of the cathode rays, $1.\ 86.10^7$, one obtains $eN = 3.\ 7.10^3$ units. Therefore, every copper atom must carry two free ion charges of electricity.

Every aspect of the design and manufacture of electrical apparatus will be dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

The Design of Induction Motors.

By H. M. HOBART.

(Continued from p. 38.)

IN the *Electrician* for April 1st, 1904, Mr. Esson published a curve giving the values of the output coefficient "ϕ," which he states are representative of the best European practice. I have plotted Mr. Esson's curve on the diagram in Fig. 1, on which I have also shown the values of ϕ for thirteen three-phase induction motors of eight different Continental firms. I have had occasion to analyse these thirteen designs, and have published full descriptions of them on other occasions.*

In Fig. 1 results for Continental motors are indicated by circles, and for British-built motors by rectangles. In Table III. is shown in a calculation arranged tabularly, and in the order of increasing values of $D^2\lambda_g$, the derivation of ϕ for these thirteen cases.

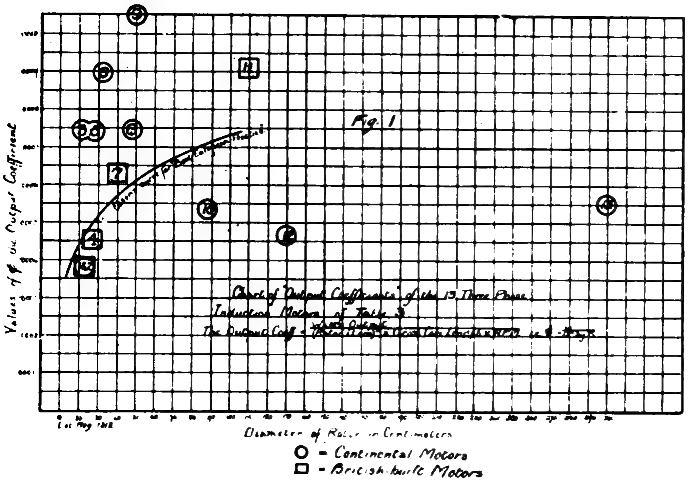
The occasion for Mr. Esson's publication of the curve in Fig. 1 was a contribution to the discussion of a paper of mine,† in which

* *Traction and Transmission*, vol. viii., p. 46, September, 1903; *Electrical World*, vol. xliii., p. 805, April 30, 1904; "Electric Motors," London, Whittaker & Co., 1904; "Motoren für Gleich und Drehstrom," Berlin, Julius Springer, 1905.

† "The Rated Speed of Electric Motors as Affecting the Type to be Employed," "Proc. Inst. Elect. Engrs.," vol. xxxiii., p. 472, 1904.

TABLE III.

Reference Number.	Manufacturer.	Rated Horse Power Output.	Watts Output.	Synchronous Speed in Revolutions per Minute (R).	Periodicity.	Terminal Voltage.	Squirrel Cage or Wound Rotor? (S or W).	Rotor Diameter in Centimetres (D).	Number of Poles.	Polar Pitch at Air Gap in Centimetres (τ).	Gross Core Length in Centimetres (λ_g).	$D^2\lambda_g$.	Output Coefficient (ϕ) $\left(\phi = \frac{W}{R \times D^2 \times \lambda_g}\right)$
1	Allgemeine Elektricitäts Gesellschaft	3.0	2,210	1,500	50	120	W	21.4	4	16.8	8.4	3,850	0.00038
2	British Thomson-Houston Company........................	3.5	2,610	1,500	50	200	S	20.3	4	15.9	10.8	4,450	0.00039
3	Brown, Boveri and Company ..	8.0	5,890	1,500	50	250	S	21.0	4	16.6	12.0	5,300	0.00074
4	Dick, Kerr and Company	5.0	3,730	1,000	50	400	W	25.3	6	13.3	12.7	8,100	0.00046
5	Société Alsacienne de Constructions Mécaniques	15	11,050	1,500	50	110	W	25.9	4	20.4	15.0	10,000	0.00074
6	Brown, Boveri and Company..	25	18,400	1,000	50	240	W	32.0	6	16.8	20.0	20,500	0.00090
7	British Thomson-Houston Company..........................	25	18,400	1,000	50	200	W	38.1	6	20.0	20.3	29,400	0.00063
8	Adolf Ungers Industri Aktiebolag	45	33,100	690	46	380	W	49.3	8	19.4	26.5	64,300	0.00075
9	Brown, Boveri and Company ..	75	55,100	750	50	500	W	50.0	8	19.7	28.0	70,000	0.00105
10	Allmanna Svenska Elektriska Aktiebolaget	100	73,600	500	50	500	W	87.7	12	23.0	36.0	277,000	0.00053
11	Dick, Kerr and Company	220	164,000	500	50	5,000	W	108.7	12	28.5	30.5	360,000	0.00091
12	Alioth..........................	185	136,000	430	50	8,000	W	129.8	14	29.2	40.0	672,000	0.00047
13	Alioth.....	500	368,000	100	25	5,000	W	299.7	30	31.4	75.0	6,720,000	0.00055



shown* that for large motors, the most economical result is obtained by designs of such proportions that $\lambda g = 1.4\tau$, where τ = polar pitch in centimètres. From this relation, the following formula may be deduced :—

$$\tau = 0.079 \sqrt[3]{\frac{W \times R}{\phi \times N^2}}$$

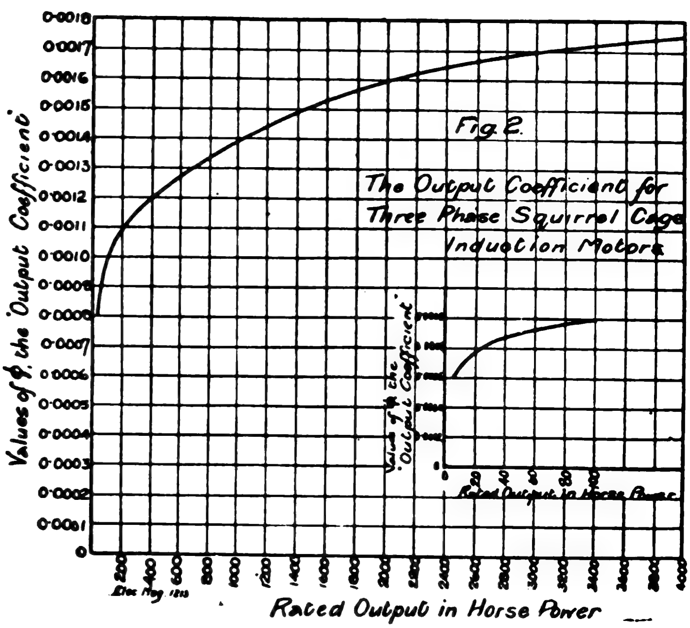
in which
W = Rated output in watts.
R = Speed in revolutions per minute.
N = Periodicity in cycles per second.

Now, as W, R, and N constitute the three chief factors with which the motor must be designed to comply, we have in the above formula the means for determining a preliminary trial value for τ. It is expressly intended to indicate that this shall merely be regarded as a preliminary, although rational, trial value, for, as we shall see later, the motor may often be improved in quality at some sacrifice in cost by the use of larger or,

I had given the data of six 150h.p. induction motor designs having output coefficients ranging from 0.0010 to 0.0014. For motors of that size, however, such values of ϕ are not only attainable for certain periodicities and speeds, but they *must* be attained by firms contemplating competing successfully in the present market.

A conservative curve of values for ϕ, below which there should rarely be occasion to go, is given in Fig. 2. Of course, there arise cases where, in the interests of using laminations of some single standard diameter for a considerable range of ratings, it is cheaper for the manufacturer to employ values of ϕ lying considerably below this curve, in certain sizes, but this will be offset by the values in other cases, which will be considerably above the curve. We shall, however, take this curve, so far as relates to squirrel cage motors, as the basis of our method of design.

Now, having given ϕ, we are only in a position to derive from the curve of Fig. 2 the value of the product $D^2\lambda g$, for any given case; we are still in the dark as to what values to give to D and to λg. Granting certain premises, the author has



* "A Method of Designing Induction Motors," Paper read before the International Electrical Congress (Section G), St. Louis, 1904.

occasionally, smaller values of τ than that derived by the formula. If P equals the number of poles, then, obviously, $D = \frac{P \times \tau}{\pi}$, and we have fixed the value of one factor, D^2, of the quantity $D^2\lambda g$. From the equation $\lambda g = 1.4\ \tau$ we obtain the other factor, λg. But we must be careful not to employ the relation $\lambda g = 1.4\ \tau$ for determining the one quantity from the other, except in cases designed for minimum cost in accordance with the assumptions of the theory just referred to. For other cases we should obtain λg from the equation $\lambda g = \frac{W}{\phi \times D^2 \times R}$ and, of course, this formula may be used in any case.

The smaller the rated capacity of the motor, the higher the periodicity and the lower the speed, the more probable is it that the value of τ (consequently also of D), obtained as above described, will give too inferior technical constants to permit of competition with motors on the market. But from 100h.p. upwards, and especially for very large motors, the above method leads to a good first approximation not only to the cheapest, but also to the best design.

For large motors the writer employs the following formula for a preliminary determination of the radial depth Δ of the air gap: $\Delta = 0.0006 \times \sqrt{D \times \lambda g \times V}$, in which V = peripheral speed of rotor in mètres per second. This formula generally leads to unsatisfactory values in extreme cases, for instance, for high-speed motors of small capacity it will generally give too high a value for Δ. It has, however, the rational basis that Δ should be a function of D, λg, and V, and rather than employ a more complex formula in which different powers of these three variables would occur, the author prefers to obtain his preliminary value by this simple formula, and modify it as the design progresses.

(*To be continued.*)

Designers of

Electrical Plant and Apparatus

should contribute to this section.

The Annealing of Non-Ferrous Metals.

By DARWIN BATES, M.I.E.E.

It is a well-known fact that all metals can only be worked up to a certain degree before annealing, or re-softening has to be resorted to—the period or exact position when such annealing becomes necessary depending not only on the class of metal, but on the degree of fineness required in the finished article, and somewhat in regard to the tools used.

Even a small amount of hammering, rolling, or drawing applied on a wrought metal does appreciably harden it by upsetting the natural molecular structure. This hardening increases in direct proportion to the work done until a point is reached when the metal becomes so hard and brittle that re-softening is imperative before further working can proceed.

The softening process, with which this article is intended to deal, does not, to the uninitiated, seem to present any great difficulty, and it is only when a study is made of the subject that the troubles met with by the earlier students have been successfully overcome, and steady progress made from time to time with the aid of better knowledge of the subject. Within the last year or so an invention on totally new lines has been largely adopted, which is automatic in its action, and whereby any non-ferrous metal is perfectly annealed at a minimum of cost for labour and absolutely free from oxides or scale.

All non-ferrous metals excepting the rarer ones, such as gold, platinum, &c., have, when heated, a great affinity for absorbing the oxygen contained in the atmosphere, and this amalgamation of oxygen and metal creates a film more or less thick on the metal undergoing the annealing process. When the metal is cooled down, it is found that the outside skin has been converted into an oxide of the metal, which naturally must be removed before further progress can be made.

Unfortunately, no records seem to exist to show how our ancestors managed to get rid of these oxides. Undoubtedly they did, as is evidenced by the numerous articles of copper, silver, and other metal ornaments and utensils which have survived to the present day, and which, owing to their unique workmanship, must have undergone the annealing process many times, and no

doubt had, in consequence, a hard scaly oxide formed on them. One can only imagine that these early workers must have taken these oxides off by mechanical means, such as beating or scraping. Strong acids have also been brought into play, which, when diluted or in original form, could be used to dissolve these oxides by chemically converting them into solutions, such as sulphate of copper, sulphate of zinc, sulphate of nickel, or nitrate of silver, and, curious to note, although this is at best a clumsy, dirty, and wasteful method, it is still used in this country to a very great extent.

Further improvements on the older methods have been adopted, in which sealed receptacles were employed to exclude the air, but the imprisoned oxygen was always found to attack the surface of the metal, and complete annealing was not possible. The labour cost of handling the articles was also too excessive to allow of the methods becoming generally adopted.

A furnace on quite new lines has recently been brought out, which is known in all manufacturing countries as the Bates and Peard process, and which, although only practically demonstrated in England about three years ago, is now adopted by all the most up-to-date and progressive manufacturing firms in England, the United States, Germany, France, and Belgium.

This process provides not only for the annealing of metals absolutely free from oxides or scale, but has a mechanical means of loading and unloading the furnace, thus reducing the labour cost to a minimum. It has the further advantage that only the article to be annealed is heated up and cooled again, so reducing the fuel used to a minimum also.

The furnace consists of an air-tight chamber or tube, the ends of which descend and are sealed by or terminate in water. This chamber is suitably built in a brick or other heating furnace, and can be fired by gas, oil fuel, or coal, as most convenient. Fig. 1 gives a longitudinal section showing this apparatus, *a* being the annealing chamber or retort, and *b* the furnace in which it is heated. It may be a reverberatory or other suitable kind. At either end of *a* are downwardly-inclined mouthpieces, *c*, the lower ends of which are open and dip into and are sealed by water contained in the tanks, *d*. The endless conveyor, *e*, which travels round the drum, *f*, and is mounted on the shaft, *r*, passes the metal to be treated through and out of the retort, *a*. The tanks *d*, are connected by a pipe, d_1, through which the lower part of the conveyor, *e*, passes from one tank to the other. The drums, *f*, can be driven by a toothed wheel or rack, *h*, at one end of the drum, *f*, and a tooth pinion, *i*, on shaft i_1. This pinion is operated by a ratchet wheel, *j*, also fixed on the shaft, i_1, and adapted to be driven by a pawl, *k*, on arm, k_1, which receives a reciprocating motion from a suitable actuating apparatus, such as an eccentric.

The conveyor, *e*, is guided within the tanks, *d*, by rollers, *l*, fastened to the sides of the tanks, while the guide plates, l_1, prevent the metal carried from fouling the rollers. When starting up, steam or other non-oxidising gas is blown in at one end of the retort, to drive out any atmospheric air which may remain in erecting the furnace, and this is done through the pipe, *m* and *n*, on the two ends of the mouths, *c*.

Fig. 2 is from a photograph of a large furnace which has been erected at the works of British Insulated and Helsby Cables, Ltd., at Prescot, and is used for the annealing of copper, to make it suitable for electric cable making. This furnace is a very large one,

Fig 1

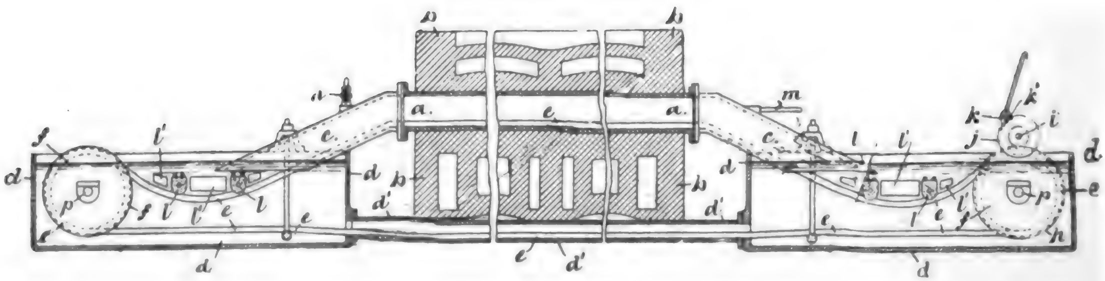


FIG. 1 SECTION THROUGH BATES-PEARD ANNEALING FURNACE.

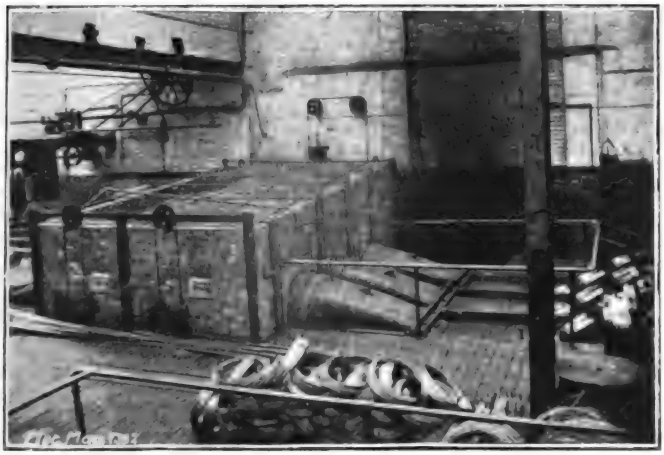


FIG. 2.—ANNEALING FURNACE AS INSTALLED IN LARGE CABLE WORKS.

and capable of annealing fifty tons per day. It has been in daily operation for three years, and has given complete satisfaction.

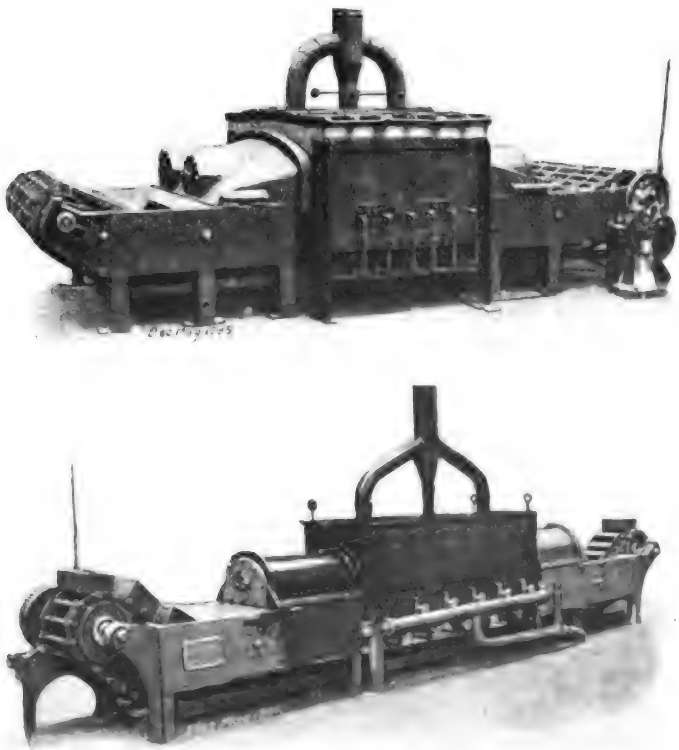
Notwithstanding the large output of this furnace, and the enormous amount of work it is capable of doing, it is run by two men, one operating the metal and another stoking and wheeling away the clinker. The operating costs work out at tenpence per ton for power and labour, the coal consumption being 114lbs. of slack coal per ton of metal annealed.

Figs. 3 and 4 represent similar types of the same class of furnace, which have been designed to fill the needs of factories having either a smaller output or where coal firing cannot be resorted to. Both these types of furnace are heated by gas fuel, and can be placed in any convenient position or corner of a shop, adjoining the spot where annealing is required. Fig. 3 is a furnace adapted for sheets or strip metal in almost any form, it having a wide open mouth which enables sheets to be put in on the flat.

It is also fired by gas fuel, and to cheapen the first cost of production, the endless conveyor chain has been brought outside the furnace framing, the driving mechanism being a ratchet and pawl working on to the sprocket shaft by a worm and worm wheel. The output of this furnace is about six tons per ten hours' working day.

Fig. 4 shows a still smaller type, but exactly similar to Fig. 3, and this has been designed for annealing small articles such as cartridge cases, coin blanks, small coils of wire, &c. The output of this furnace is 30 cwt. per ten hours day.

Metal workers have been trying for a generation past to improve their methods of annealing. The discovery of Messrs. Bates and Peard, that a solid mass of water could be utilised to form the entrance to a furnace, and also an exit, practically revolutionised the known methods of annealing.



FIGS. 3 AND 4.—TYPES OF THE BATES-PEARD ANNEALING FURNACE.

A Novel Type of Dynamo.

A TYPE of dynamo suitable for the lighting of railway trains, as it will give a current of constant intensity without the aid of auxiliary apparatus, has been designed by Dr. E. Rosenberg, and is being brought out by the Allgemeine Elektricitätsgesellschaft. The transverse field at right angles to the primary field in ordinary dynamos gives rise to inconvenient deformation of the main field. This transverse field has been turned to practical use by the inventor. The dynamo is a two-pole machine which is practically identical with the ordinary machine, except that a second pair of brushes has been added. The brushes corresponding to those of the ordinary dynamo are short circuited. The flux in the machine may be very small in the event of the machine running at full speed. It will suffice, however, to induce a small electromotive force in the armature, and drive through the latter the normal current or part of it while the brushes are short circuited. The armature current will produce a transverse field of much greater intensity than the primary field, and displaced 90° in the direction of rotation. The armature reaction always weakens the field in the leading edge of the pole-shoes, reinforcing it in the trailing edge. If the main brushes of the machine be connected with any external resistance, the armature current derived from them will generate a field transversely with regard to the acting field, and in advance by 90° in the direction of rotation. This tertiary field is displaced with respect to the secondary field by 90°, and with respect to the primary field by 180° in either direction of rotation. If the current derived from the main brushes be greater than the auxiliary current flowing between the short circuited brushes, the tertiary field will be greater than the secondary field in the diagrams of ampere-turns. In order to allow the armature current to develop perfectly, a further number of ampere-turns should be arranged on the magnet system, accurately counterbalancing the back turns of the armature. If the machine were to be designed for ordinary purposes, the number of ampere-turns would be reduced by an additional main current winding, so as to compensate for the armature reaction at any load. With machines intended for working in parallel with accumulators, and especially in the case of train-lighting dynamos, a different practice should be adopted. The primary exciter coils are connected to the accumulators, so that a number of balancing ampere-turns is present at the very outset. At medium speeds the number of ampere-turns required for generating the primary field is about 10 per cent. of that necessary for the armature compensation. The exciter coil thus receives a number of ampere-turns only greater by 10 per cent. than the number required for the compensation of the normal effective current, while the current flowing between the short circuited brushes is about 40 per cent. of the normal effective current. Any increase in the latter weakens the primary field, and accordingly weakens the magnetising current between the auxiliary brushes. Though the speed may be increased up to double or a higher multiple of the average speed, the effective current in the armature will never increase more than 10 per cent. beyond its actual value. On reaching this value the armature ampere-turns will be perfectly equivalent to the primary ampere-turns, so as to leave no primary field.—*Electrical Review* (London).

Central·Station·Practice·

The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

Continuous Current Networks, Metallic and Non-Metallic Sheathed Cables.

By L. R. LEE, Manchester.

(Continued from page 42.)

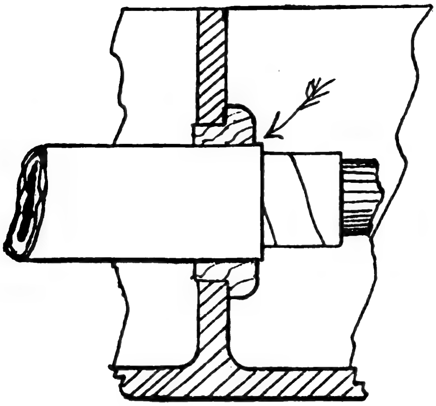
BEFORE leaving the subject of design in joint-boxes, it may be well to point out that most boxes err in not being large enough, chiefly in length; and it is in the short box that troubles arising from moisture will take place. Fig. 2 (p. 110) shows the point where length comes in to obviate the creeping of moisture. In the short box very little of the sheath of the cable, if any, can be allowed to project inside the wood bush, but this portion of sheath, be it lead or otherwise, should be at least ¾in. long; the filling compound then gets a chance of adhering to the sheath, which it will always do if the sheath is warm, clean, and dry. On the other hand, if the sheath is cut nearly or quite level with the face of the wood bush, any water finding its way between the compound and the side of the joint-box will first soak the wood bush to saturation and finally get on to the paper or other dielectric, and the consequences are only what might be expected.

With reference to the use of disconnecting boxes it must be very evident that a box which would suit very well on some of the smaller networks would be absolutely useless for disconnecting or distribution purposes on the larger networks. In Manchester, for instance, where during heavy load as much as 2,000amps. are distributed from one box, something solid and substantial is required, and for networks of such dimensions a brick box, equipped with a Wordingham patent pillar, takes a lot of beating.

In any case, whether the box be of iron or brickwork, designs can now be found in which the cables do not rely on the filling compound for their support. A box suitable for distributing heavy currents of this nature should cost about £25 complete, in either material, exclusive of cables. As to fusing the cables, in a box of such dimensions that it could be fitted up in the works, it would certainly be unwise to blow fuses capable of carrying 800kw. plus their overload capacity.

With regard to the use of overground fuse pillars, they are certainly useful in certain ways, probably not so much as fuse pillars as quick disconnecting pillars, and their use will most likely be brought about by the increase in the size of network, *i.e.*, its area, rather than by increase in pressure, as with a large network fed by many substations, in which the machines are all fitted with automatic circuit breakers, in the case of a fault developing the fuses would not blow, as the circuit breakers would act immediately, the time element spoiling the fuses. The circuit breakers could, of course, be locked in and the machines run until the fuses were blown, but there would be many difficulties brought in by so doing—the wrong fuses would often be blown through overload, owing to the substations starting up at different times.

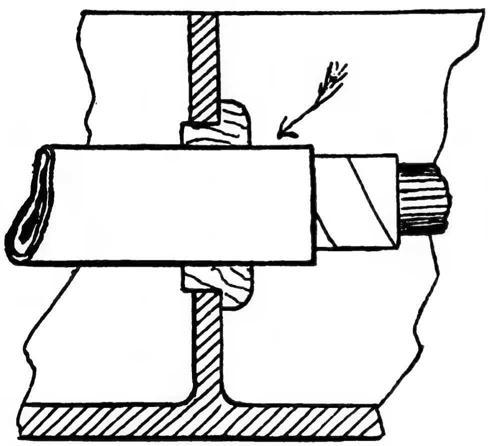
It must also be borne in mind that with the use of fuse pillars *ad. lib.*, granting the blowing of the fuses, portions of the network would probably become detached from the balancing stations, so that the number of



Faulty Design

Fig. 2.

Improved Design



these stations would have to be increased in proportion as the network was divided.

A large low tension network fed from one switchboard, say about one square mile in area, can conveniently, by means of these pillars, be divided into four or five parts, each with its group of feeders and its balancer, and a very useful addition to each subdivision is a middle wire equipped with its own separate ammeter at its connection with the common earth of the system, all wires being brought back to the one generating station. The junctions between the subdivisions should be kept as few as possible, and the cables joining them should be of ample sectional area to carry heavy overload currents at times of fault, and the pillars should theoretically be placed at a neutral point between two feeding points. Practically there is no neutral point.

Even with these pillars installed, it may not always be possible to avoid a total shut down, in the case of heavy fault, seeing that normally all the feeders would be in parallel at the station, but such shut down would only last long enough to allow of the group of feeders involved being taken out, and the fuses outside would certainly act in a case of this sort, and would save the distributors from being burnt out through overload. About the only risk that is run with the use of these pillars is the risk of their being run into by heavy lorries and broken up. Two cases have occurred in Manchester where steam motor lorries have skidded into traction boxes, breaking the boxes off close to the ground; the boxes have necessarily to be fixed near the kerb.

With regard to the localisation of faults, it is not so much the length of time taken to locate the fault that one worries about, but the length of time taken to get to it, on a network covering say forty square miles; and it is highly probable on a network of this size that the nearest policeman has already located the fault long before the mains men know anything about it; and supposing the fault is an earth and not a short, how is one to apply the test inside ten minutes if all that is known as to its locality is that it is somewhere within forty square miles? After years of work on large networks, one begins to see some truth in Mr. Wordingham's statement that a pick and shovel are not bad instruments for fault location.

But having run an earth down to one length of cable, which it is impossible to make dead on account of consumers, not a bad test is the following: The implements required are a voltmeter, a short length of wire, and another length, say 100 yards long, and a flat metal plate, say six inches square provided with a terminal. The *modus operandi* is:—Connect one end of the short wire to one terminal (positive if the fault is a negative, or *vice versâ*) of the voltmeter, and the other end to a good earth, such as a water- or gas-pipe; connect one end of the long wire to the other terminal of the voltmeter and the other end to the flat metal

plate; get an assistant to carry the plate to the extent of the long wire and to place it on the ground over the cable, then slowly to draw the plate over the ground towards the voltmeter, keeping as much as possible over the line of the cables; as soon as the position of the fault is reached, the voltmeter will read anything up to fifty volts. If the faulty main is longer than the test wire, it can, of course, be worked in sections; but to carry out this test the middle wire must be kept earthed, either dead or through a resistance, at the station, the working of the test being dependent, of course, on the difference of potential between the ground surrounding the fault and the middle wire or actual earth.

With this test all the supporting bars in a bare strip culvert have been located by simply drawing the plate mentioned over the line of culvert. In this case, owing to the small leakage-current passing over the bars to earth, a millivoltmeter was used. With regard to the house services, in spite of Mr. Cleary's warning that the service cable must not make a "good earth," yet the gas-pipe through which the cable is pushed (after the use of the very ingenious tool described) does form an earth of some sort, sometimes good and sometimes bad, unless other precautions are taken which have not been mentioned; and if these precautions are not taken, then the whole system of lead sheathed cable is more or less earthed at many points, and the lead is continuous everywhere. Again, the fuses for maintaining supply to a service would probably not act twice in the same way; as the fuses are in series on the mains, either one or both would be quite in order in blowing, let the fault be where it would.

(*To be continued.*)

Automatic Synchronisers.

In the June issue we gave some preliminary details and a diagram of connections for the latest thing in synchronisers, and we now are able to supplement that data from a paper on the subject recently presented to the National Electric Light Association, by Mr. P. McGahan. His preliminary remarks are chiefly historical in character, so can be passed over, as the common methods of "phasing" alternators are well known. His reference to the Pearson device is, however, interesting.

"One of the best known of the early attempts at automatic synchronising was the Pearson synchroniser. This consisted of two controlling magnets mounted in the same case, each magnet serving to close a contact. The two contacts were connected in series with the closing coil of an electrically operated switch, the magnet coils being connected in parallel, and connected to the incoming machine and bus bars in the same manner as incandescent lamps are connected in synchronising. One of the magnets was provided with a movable iron core, retarded in its motion by a dash-pot, thus requiring an appreciable length of time to make contact, and operated to select a wave or "dark period" of the lamps of sufficient length to give the main switch time to act and still render coupling safe. The other magnet had a free, or instantaneous, action, adjusted to close its contact only when the voltage across the synchroniser coils corresponded to a coincidence of the phases. Thus in action, the magnet with the time element would close its contact when the difference in speed was small enough, and the other magnet would complete the switch-closing circuit when the machines were in exact synchronism.

"The device makes no allowance whatever for the length of time required by the switch to act; it is true that the quick-acting contact may be adjusted to operate at a voltage corresponding to a slight difference in phase, so as to make contact ahead of time, but this would mean that it could make contact the same length of time too late; if the speed suddenly changes after the slow solenoid has closed its contact, there is danger of the second contact closing. Besides, the angular advance of the contact would not vary with differences in speeds, thus coupling the machines at too early a period when they approximated in frequency, and too late when they differed considerably, for the switch requires a constant time to close. These defects alone were sufficient to cause accidents in operation, except under particularly favourable circumstances, and thus rendered the device commercially a failure. However the inventor deserves great credit for taking the first step in automatic synchronisation, and pointing out the advantages that would accrue with a device that would infallibly do the work.

"The latest development in automatic synchronising differs entirely in its operation from the Pearson synchroniser. This new synchroniser consists of a pair of solenoids,

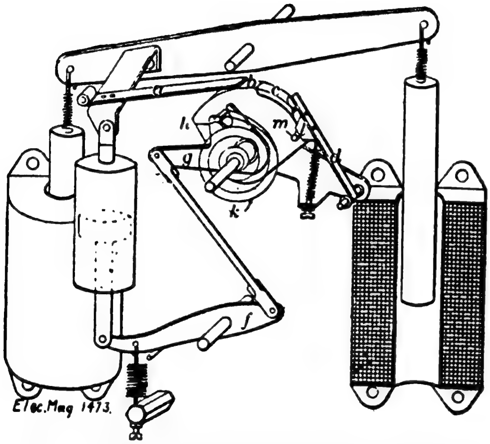


FIG. 1. MECHANISM OF AUTOMATIC SYNCHRONISER.

each actuating a laminated iron core, supported from opposite ends of a rocker arm. Each solenoid is wound in eight separate sections, alternate sections being connected in series, thus forming two circuits in each solenoid; one circuit of each solenoid is connected in series with a circuit of the other solenoid, thus forming two independent circuits in the instrument, each circuit having half of its turns on each solenoid. One circuit is connected to a pair of binding posts deriving current from the bus bars, and the other circuit to binding posts connected to the incoming machine. The connections of the various sections are so made that when the incoming machine is in phase with the bus bars, the currents in the right-hand solenoid act in conjunction, thus pulling down the core, and the currents in the left-hand solenoid neutralise or cancel each other magnetically, and produce no pull. On the other hand, when the machine is in opposition to the bus bars the currents in the right-hand solenoid neutralise and the left-hand solenoid exerts a pull, its currents acting in conjunction.

"The cores are suspended so as to reach the magnetic neutral of the coils at their extreme down stroke; thus, when the machines differ in speed, the horizontal beam rocks to and fro with a harmonic motion. As the incoming machine approaches the frequency of the bus bars, the motion becomes slower, and finally ceases when the machines are at the same frequency; if the machines are in phase, the right-hand core will stop at its lowest position, unless the voltages differ considerably, when the currents will not neutralise, and the core will not be able to reach its extreme stroke. The left end of the rocker arm carries a contact spring, marked (a) in Fig. 1, which slides along the top of a fibre segment (b). This segment has a platinum strip (c) on the top, which, in conjunction with the stationary spring (d), forms the contacts of the relay circuit. The springs and contact are of such length that, when the segment is stationary, contact can only be made when the right-hand core has reached its extreme position.

"The vital characteristic of this instrument which makes it successfully cover the requirements given for automatic synchronising not heretofore met is the peculiar motion imparted to the contact segment. Instead of being stationary, it is pivoted on a shaft concentric with the rocker arm shaft, which latter on its left half carries the chamber of a dash-pot, the motion of whose piston is opposed by a spiral spring, in the manner shown in Fig. 1. When the left end of the rocker arm rises, it tends to lift the piston of the dash-pot, and elongate the spring (e). Upon the return stroke a valve in the dash-pot opens, allowing a quick return motion. The piston rod of the dash-pot carries an arm (f), which is so attached to the contact segment as to shift the latter to the left, thus advancing the position of the contact when the rocker arm moves up with a sufficient speed to draw up the dash-pot piston. The slower the motion of the rocker arm, the less the piston of the dash-pot is raised, and, consequently, the less the contact segment is advanced.

The arm (f) does not act directly on the segment, but operates a brass fork (g), between the prongs of which is a pin (h), which is screwed into the contact segment. There is a spiral spring (k) between the contact segment and the fork which tends to keep the pin against the right prong of the fork. The pin has thus about one-eighth of an inch of play, the purpose of which will be apparent later.

"Turning to the right-hand or stationary contact spring, this spring carries a cam (l), the inclined edge of which is met by the pin (m) upon the return stroke of the contact segment. This stationary contact spring is of such strength that the pin (m) cannot raise the inclined edge of the cam, for the contact segment is being actuated through the weaker spring (k). Thus, upon its

return stroke the contact segment is delayed for an instant, until the left prong of the fork (g) touches the pin (h), and thus forces up the cam. As soon as the pin (m) reaches the end of the inclined plane, the contact segment is free, and is snapped over by the spring (k). The position of the stationary or right-hand contact spring can be varied. This, in conjunction with the adjustment of the spring (e), is for the purpose of adjusting the difference in speed of the incoming machine at which the synchroniser will couple. Thus, when the difference in speed is too great to allow safe coupling, the dash-pot piston will advance the contact segment sufficiently to drop the stationary spring away from the contact plate and down upon the insulated portion of the contact segment (n), thus preventing the contact from being closed when the right-hand core comes down. The retarded motion of the contact segment prevents contact being made as the right-hand core rises, allowing time for the left contact spring (a) to get out of the way.

"As the voltage of the incoming machine builds up and it approaches the approximate frequency of the bus bars, the rocker arm oscillates violently, the dash-pot piston advancing the contact segment so far that no contact is possible, no contact being possible on the return stroke. As the speed of the incoming machine increases, the rocking becomes slower, and the dash-pot piston advances the contact segment less, until finally the right contact spring no longer drops away from the contact, and as the right-hand core descends the left-hand contact spring advances to meet the contact, thus energising the auxiliary relay, which operates the switch-closing circuit just sufficiently ahead of the point of coincidence of the phases, so that actual coupling takes place at the exact instant of synchronism. If the machine approaches the point of synchronism more slowly, there is less advance of the contact segment, and the actual time allowed for the switch to act is the same as before. In the extreme condition, when the machine is coming in very slowly, there is no appreciable advance of the contact segment, the dash-pot having time to exhaust. The amount of the advance of the segment can be adjusted to suit switches having different times of closing, by varying the tension of the spring (e)."

This data should be consulted in conjunction with the diagram given in our June issue.

Grounds in Alternators.

By L. O'CONNOR.

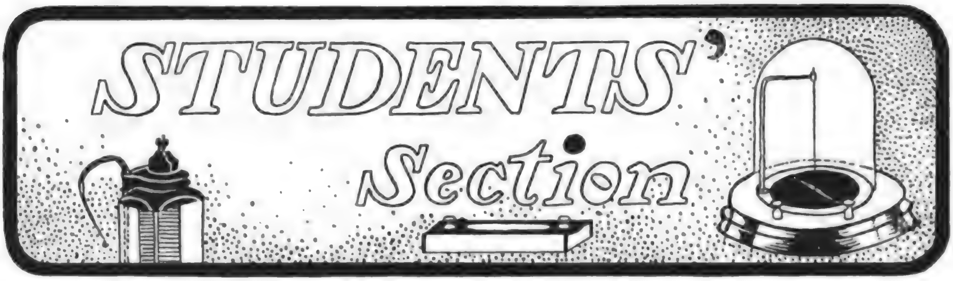
LOCATING faults in alternators is a comparatively easy matter for the expert, with his expensive instruments and apparatus, but it is not so simple a problem for the engineer of the small central station, who has probably nothing in the way of instruments except the ordinary station voltmeter and a magneto testing bell. With the bell, of course, he can ascertain whether a grounded coil really exists, but it is another proposition to locate the particular coil in which the fault lies.

A simple method of locating a ground in a single phase alternator armature, which has been utilised by the writer, is given below.

To proceed, first run the machine up to speed with main switch open and fields properly excited, then adjust rheostat until the voltage is normal. Now disconnect the primary leads of the voltmeter transformer and connect them one to the frame of the machine and the other to one of the armature terminals. The easiest way to do this if the armature is of the revolving type is to make a temporary connection to one of the brushes. If a ground really exists the voltmeter will now indicate a certain E.M.F., which will depend on the number of armature coils between the armature terminal and the grounded coil. This reading is noted and the transformer lead is then changed over to the other brush, and again the voltmeter reading taken. The sum of these two readings should equal the normal voltage if the ground is a good one.

For instance, we will suppose the normal voltage is 110, and that the pressure, as found above, between the first brush and the frame, is 90 volts, and that the pressure between the second brush and the frame is 50 volts, and we will also assume that there are sixteen coils in the armature. Then, $110 : 16 :: 60 : x = 8\frac{8}{11}$ coils between the first brush and the ground. The trouble in this case would evidently be in the ninth coil and close to where it is connected to the tenth coil. To avoid the consequences of any errors in the readings taken, remove the connection between these two coils, thus dividing the winding into two parts. By now testing each part separately with the magneto will determine whether the ground is in the ninth or tenth coil.

If the sum of the two readings does not equal the normal voltage, it indicates that the ground has a certain amount of resistance. In this case subtract the sum of the readings from the normal voltage and add one-half of the difference to each of them. This will give the corrected readings. (*Canadian Electrical News.*)



Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

The New Faraday House.

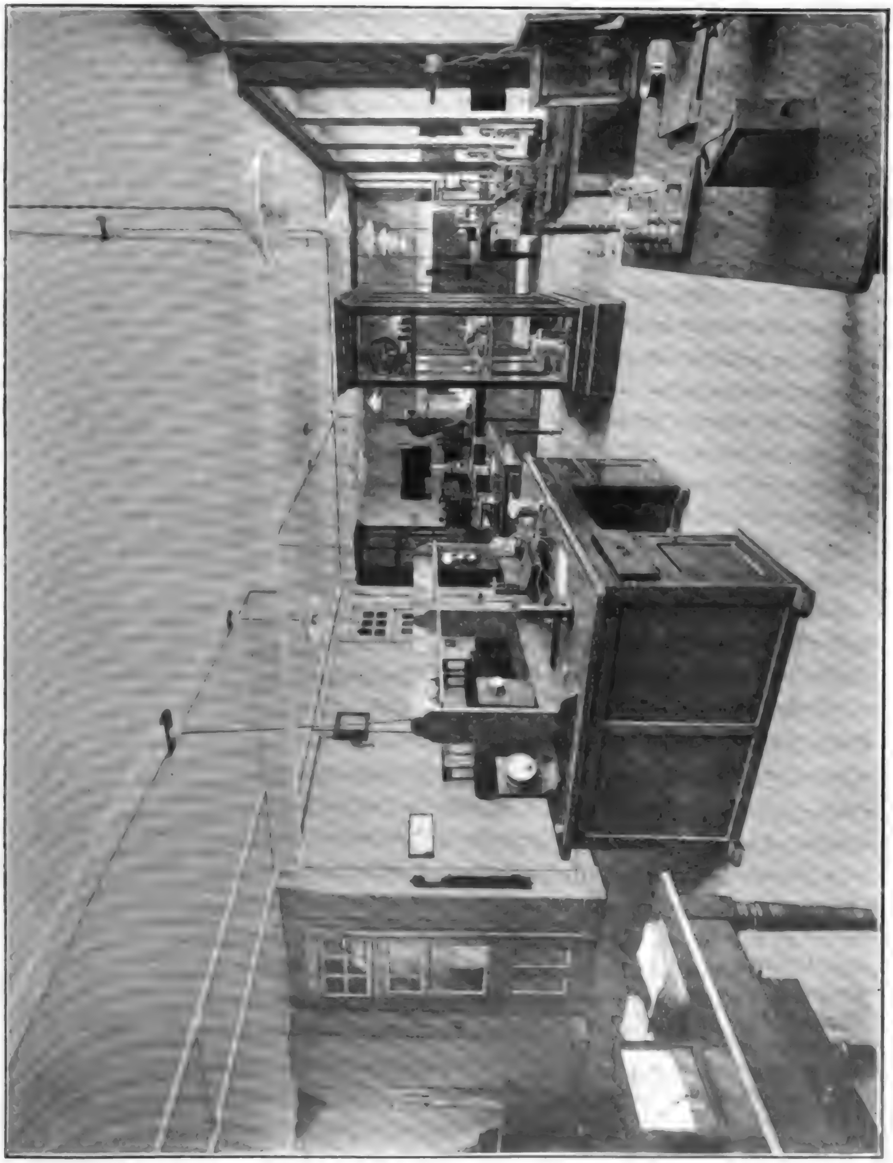
OUR student readers need no introduction to Faraday House or its admirable organ, the *Faraday House Journal.* Many of them will also be familiar with the fine new premises in Southampton Row. To the unitiated, however, we think some details and illustrations will be valued, so are presenting these through the courtesy of the Institution from the *Journal* of July.

The front elevation is Georgian in style, in keeping with the character of the surrounding neighbourhood, and faces Southampton Row a few hundred yards from Holborn and in a direct line with the new main thoroughfare Kingsway. In the ground floor and basement are the carpentry, fitting and machine shops, and engine room; on the first floor the offices and standardising department; the second floor is taken up by the physical and chemical laboratories; the third floor contains the three lecture rooms and common rooms; and the fourth floor is one big room entirely used as a drawing office. The first thing that strikes the visitor is the roomy character of the building: the windows are large and all doors are glazed so that there is ample natural light everywhere.

Running up the main staircase well is an automatic push-button lift on the Richmond-Carey system, worked electrically, and capable of carrying 10cwt. To call the lift it is only necessary to press the push and it comes to the floor; then, and not till the cage arrives, can the door be opened. When the door is shut, and not before, all that is necessary is to press the button labelled with the number of the floor required and the cage goes to it. The construction is steel and concrete, so that the risk of fire is reduced to a minimum.

The lighting of the building is carried out on a three-wire system, in wood casing, run on the service. Each floor is run independently, and is provided with its own distribution board. It was carried out by Messrs. Edwards and Armstrong of 4, Colston Street, Bristol, a firm of old students, and when it is stated that one of the fire insurance inspectors who examined it with a view to insurance declared it to be the most perfect lighting installation he had ever examined, nothing further can be said of it. The plans and specification were prepared by, and the work was carried out under the personal supervision of, Mr. Percy Good, the Superintendent of the Testing Department.

Workshops.—The basement workshop and engine room has a floor area of about 2,000sq. ft., and is well lit by two large skylights fitted with Maximum Light glass, which throws the rays of light into the shop. Indeed, although it is entirely underground the light is really better than in some of the upper rooms which get their light direct. At the north end are the lathes, seven in all, including five screw-cutting lathes, drilling, shaping, and milling machines, all driven electrically from shafting attached to a steel frame erected independently of the main fabric, to prevent vibration. Running the whole length of the shop under the main skylight is the fitting bench, 55ft. long. At the south end is the forge, the boiler, and



FARADAY HOUSE, NEW PREMISES. PHYSICAL LABORATORY. LENGTH, 60FT. AREA, 1,600SQ. FT.

steam engine, a new type of Crossley gas engine with magnetic ignition, and four electrical generators. A condenser is in course of construction. The upper, or carpenter's shop, has an area of about 1,200sq. ft. The main bench, running nearly the whole length of the shop, is 42ft. long, and fitted with Parkinson vices. There are lathes and saw-bench here, also at the south end is a unique type of motor generator specially constructed for our testing work, a special form of alternator direct coupled to a d.c. motor. By means of cross-pieces it is possible to obtain either single, two, or three phase current with varying periodicities, the regulating device of the motor allowing a wide range of speed.

Battery Room.—Outside the above laboratory on the flat at the back is a glass-covered battery room containing about fifty-four E.P.S. and other types of accumulators.

Lecture Rooms.—The lecture rooms, three in number, are on the third floor. Two have a floor area of over 600sq. ft., the smallest being about 22ft. by 20ft. The usual fitted lecturers' benches are provided, and all the rooms can with little difficulty be made into one room. It may be of interest to state that when each room is filled with the maximum number of students provided for, the air space per pupil is about 250 cubic feet.

Drawing Office.—The drawing office is on the fourth floor and is 60ft. long, the total floor area being at present over 2,000sq. ft. It is splendidly lighted both back and front, and is provided with

FARADAY HOUSE, NEW PREMISES, DRAWING OFFICE. LENGTH, 60FT. AREA, OVER 2,000SQ. FT.

accommodation for seventy students. The benches are of special pattern, having slopes for the drawing-board and a locker underneath closing with a spring catch, so that each student can put away his board, with T-square and instruments, at the end of instruction, and thus keep it free from dust.

Physical Laboratory. — The physical laboratory is on the second floor and runs the whole width of the building (60ft.), and has an area of 1,600sq. ft., being well lit back and front. It is fitted with all the necessary apparatus for making physical and electrical measurements. At the north end, protected by a strong barricade, are two motor-generator sets and one rotary converter for experimental demonstrations. An independent system of wiring runs all round the room to provide the currents required for testing purposes, whether from the Institution generators or from the street mains which supply the building with alternating current at 200 and 100 volts, and direct current at 530, 200, and 100 volts.

Chemical Laboratory.—On the same floor is the chemical laboratory, an oblong room 54ft. by 17ft., well lit by windows on both sides. Two teak benches, each about 45ft. long, run down on either side fitted with water, gas, and sinks. A special device is provided to avoid the nuisance occasioned by the stoppage of the ordinary waste pipes by the filter papers, &c., which find their way down the sinks. Each sink discharges into a lead-lined open gutter at the back of the bench, which in turn discharges into a porcelain tank, thence into a lead-lined tank, and so into the ordinary waste pipe. At one end are two fume cupboards and the other a special lecture bench for the instructor. Each student is provided with a complete set of ordinary reagents, the rarer chemicals being stored in three separate cupboards.

Library. — A very complete technical library is available for the use of students, containing nearly a thousand volumes, and every important technical work is purchased as published.

Offices. — The offices, principal's room, board room, and secretary's room are on the first floor and are large, well-fitted rooms. An interview room is also provided for parents and friends wishing to see the students. Telephones are fitted to all the main rooms.

Standardising Department.—The testing department is on the first floor. The main test room has an area of 1,500sq. ft. with an annexe 34ft. long for photometry. The battery room is on the second floor and the machinery on the ground floor and basement. The services for the supply of current for testing purposes are brought directly into the main test room. They consist of three-wire direct current, and three-wire alternating current, and a two-wire direct current at 530 volts pressure. These are connected to a large plug board, from which mains run to the lecture rooms and laboratories. As the generating plant and batteries are also connected to this board, it is a very simple matter to provide current at any pressure to any part of the building.

The wiring in the test room consists of three pairs of mains running round the room, connected at intervals to terminal boards. One wire of each main is looped into a small plug board to which all the sub-standard ammeters are permanently connected. By this means the current in any main can be connected to any ammeter balance or standard resistance without breaking the circuit. For distributing small currents a system using ordinary wall plugs has been devised, which has been found most useful. For large currents four Pritchett and Gold accumulators are used, from which 2,000 amperes are frequently taken, although their normal maximum rate is only half this. For alternating current a Berry transformer giving 1,000 amperes at 5 volts pressure on the secondary winding is used.

The photometer room is equipped for testing arc lamps, glow lamps, gas and oil burners. To give some idea of the range of work, it is interesting to note that they have lamps running life tests at four different pressures between 18 and 100 volts and three pressures between 100 and 220 volts. For cable work a Kelvin galvanometer is used, the table carrying the scale being fitted with a tank. It is worth mention that all spots of light used in the test room can be read in broad daylight without the use of curtains. This is due to the use of Nernst lamps, which have been found very satisfactory. One bench is fitted up for iron and steel testing, and one bench is arranged solely for tests requiring very high alternating pressures. The aim throughout is to have all the apparatus for standard tests permanently connected up in order to save delay.

The Jubilee of the Swiss Polytechnic.

By LEON GASTER, F.P.S., A.M.I.E.E.

Considering the fame attained by the Swiss Polytechnic School, one would hardly believe that it has only been founded for fifty years, and as an old pupil I have much pleasure in showing my respects and gratefulness to the *alma mater*, in writing a few words in commemoration of this celebration.

It was in the year 1854, on March 7th, that the Swiss Federal Government passed a Bill dealing with the erection of the Polytechnic and appointed a committee to frame a programme of studies to be undertaken at this school, and which should be in conformity with the needs of the country. The report issued by the committee was accepted on July 31st by the Federal Government and the necessary credits were passed for establishing this institution. The first Board of Education consisted of the following gentlemen :—Dr. J. K. Kern, president; Messrs. A. Escher, Tourte, B. Studer, A. Keller, A. Humbert, and A. R. Planta.

Among the first professors appointed there are names to be found which are now famous the world over, such as Gottfried Semper, Carl Cullmann, Wolfgang von Deschwanden, who was appointed as the first director of the Polytechnic, Gustave A. Zeuner, R. J. J. Clausius, Franz Ruleaux, &c.

The official celebration of opening the Polytechnic took place on October 5th, 1855, in Zürich, and the total number of regular students registered was only 68, of which 65 were Swiss and 3 foreign, and 101 outside students—those who are permitted to attend certain courses without being obliged to be enrolled as regular students.

The fame of the school has grown so rapidly abroad that the proportion between native and foreign students has become for certain departments larger for foreigners than natives, so in the year 1904 the actual number of students attending the school was over 2,000, of which 1,293 were regular students and 735outsiders. In the mechanical department there were 261 Swiss against 287 foreign, and in the engineering department 125 Swiss against 61 foreign, in the chemical engineering department 123 against 107 foreign. It may be interesting to note that although Switzerland is such a small country, the Federal Government contributes about seven-eighths of the total expenses in keeping up the school, against about one-eighth contributed by the students from the fees paid.

The foreign and native students are treated on an absolutely equal footing, the fees being identical, and under these favourable conditions education is cheaply obtained. To limit the number of students in proportion to the available space for accommodation, an entrance examination is requested, and the age for admittance is above eighteen.

The housing of the students at the foundation of the school was in different buildings, but in the year 1865 the main building was erected at a cost of about £75,000. With the increased number of students a special chemical laboratory was built, a physical and electro-technical laboratory; also, in the years 1883 to 1885, a testing laboratory for building materials, like iron, cement, bricks, stone, &c., was also built, and in order to satisfy the growing demand for improving education for the mechanical engineer a special laboratory was erected for that purpose, and opened in the year 1897 under the guidance of the renowned Professor Dr. A. Stodola, whose standard work on steam turbines is much appreciated.

In the electro-technical department, which is affiliated to the mechanical department, are the following professors:—Drs. H. F. Weber, Wyssling, Lorentz, Denzler, Tobler, Farny, and other assistants; but on this occasion I cannot forget to mention in particular the name of the much respected Professor Dr. H. F. Weber, director of the physical and electro-technical laboratory of the Polytechnic, whose labours and the great zeal and activity displayed I have always admired. There is no doubt that the personal influence of the teacher who comes in daily contact with his pupils makes itself felt also after leaving the school benches, and I can say that I have never forgotten the great interest Professor Weber took in his work, and the true love for scientific research which he instilled into our minds.

The festivities for the celebration of the Jubilee lasted three days, from July 28th to July 30th, and they were attended by a very large number of old students, past pupils, and delegates from the different schools. In reading the speeches made on the different occasions during the celebration, it was

interesting to note the great appreciation for the work done by the school for furthering the industrial development of the country; and the opinion was unanimous that the influence of technical education has been proved beyond doubt to be beneficial for the welfare of the country.

The present president of the Board of Education is Professor Dr. Gnehm; the director Professor Dr. Jerome Franel; and the rest of professors and assistants, numbering over 100, may all be congratulated on the results achieved.

The value of education as an international asset is well recognised, and to no small degree has the Polytechnic contributed its share. It is to be hoped that the future generation, in celebrating the centenary of the school, will look back with the same pride to their *alma mater* as I do when writing these few lines.

How to make an Electric Buckboard.

By J. C. BROCKSMITH.

(*Continued from p. 50.*)

(We inadvertently omitted to acknowledge the source of these articles in our last issue. We take this opportunity of extending our apologies for this oversight to our esteemed contemporary, the "American Electrician," in which the series is published.)

CROSS pieces of ash are provided at the front and near the centre to serve as supports for the steering connections. Toward the rear there are two cross-bars of $1\frac{1}{2}$in. 20 gauge steel tubing which support the motor. All of these cross pieces are bolted

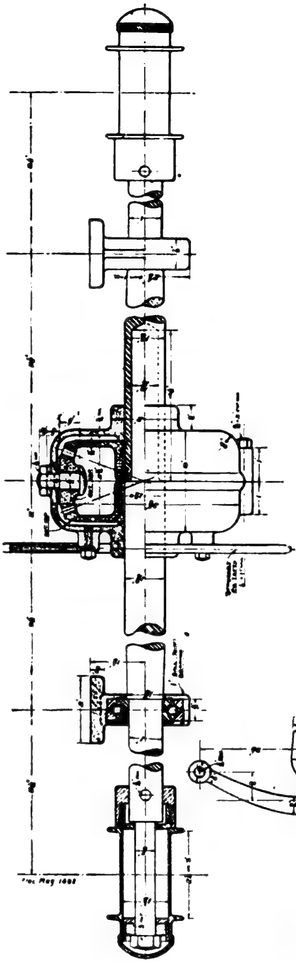


FIG. 4.

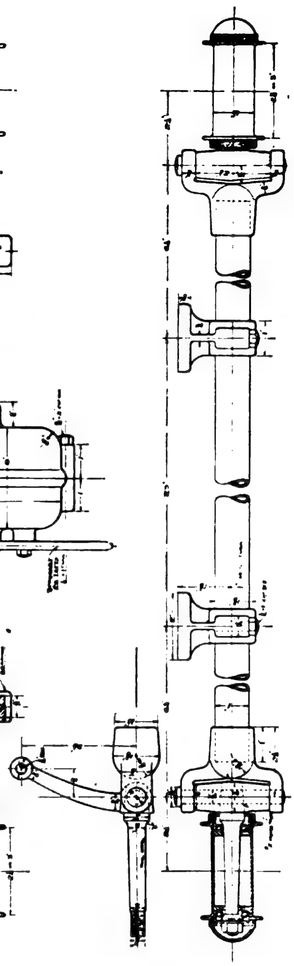


FIG. 6.

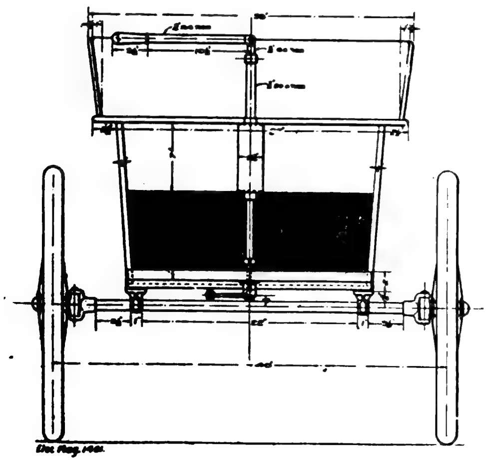


FIG. 3. FRONT ELEVATION OF BUCKBOARD.

to the frame with $\frac{5}{16}$in. carriage bolts, the frame being drilled with holes properly located to receive them.

The motor must be located somewhat off the centre, of course, in order to allow the differential gear to be placed in the centre of the axle. Fig. 3 is a front elevation of the buckboard showing the location of the steering knuckles and controller, &c., and contains some dimensions relating to the seat which do not appear in other views. The front of the battery compartment under the seat should be covered with a screen of wire cloth or perforated sheet metal, which permits ventilation of the battery and presents a finished appearance. The metal should, of course, be well painted to prevent corrosion.

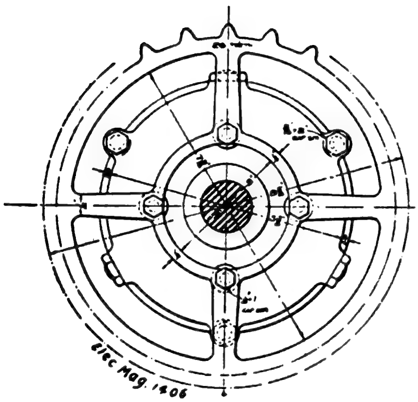


Fig. 5.

Fig. 4 shows a semi-sectional view of the rear axle. The most satisfactory material out of which to make the axle is a bar of $1\frac{1}{4}$in. nickel steel. The centre portion is turned down to $1\frac{3}{16}$in., tapering to $1\frac{1}{16}$in. just inside the bearings. From the bearings to the hubs the size is 1in. The bearings are of a standard size and type which can be purchased from any one of several makers of ball-bearings, and are of the "grooved shaft" type, consisting of a tool-steel spool slipped over the shaft, and two hardened rings fitting the case, one of which is threaded for the purpose of adjusting the bearing. $\frac{11}{32}$in. balls are provided in this size of bearing, and these are satisfactory for the load and speed used.

The method of fastening the hub on the axle will vary somewhat with the type of hub selected. In cases where good-sized tandem or quad hubs are used, these are made threaded for a sprocket. A steel cap is made to fit this thread, the cap in turn being pinned to the axle. The axle within the hub is turned to fit the holes in the ball cups and provided with a nut and washer at the outside end.

In the centre the axle is, of course, divided, one half being turned down to $\frac{13}{16}$in., which fits into a bored hole in the other half $4\frac{1}{2}$in. deep. Each half axle has a bevel gear keyed to it, which meshes with three bevel pinions secured on studs projecting through the gear case. These gears should all be cast of good phosphor bronze and need not have cut teeth, cast teeth being good enough, providing, of course, that a good metal pattern with cut teeth is used.

The differential gear case is cast from aluminium alloy containing about 25 per cent. zinc. It is provided with lugs at the side for bolting on the sprocket, and there are lugs on the periphery for bolting the two halves of the case together and also to form seats for the pinion studs.

Fig. 5 serves to show the location of the various bosses on the outside of the gear case. The sprocket is a regular 26-tooth bicycle sprocket with four arms and open centre for $\frac{1}{4} \times 1$in. chain. It has four holes for attachment to the pedal, but these are utilised in the present case for fastening it to the gear case. The most satisfactory chain to use in connection with this machine is one having nickel steel side links and hardened steel blocks and pins. Any chain of ordinary soft steel soon stretches and wears so as to be unusable.

Fig. 6 shows the front axle. This is built up of a piece of 1in. 14 gauge steel tubing fitted with phosphor bronze axle ends and steering knuckles. Cycle hubs may be used, a hub being selected which has a $\frac{7}{16}$in. axle. The cups on one side are reamed out to pass a half-inch rod. One-quarter inch steel balls are used. The bearing portion of the axle is turned from a $\frac{3}{4}$in. bar of tool steel and the portion on which the balls run is hardened while the rest should be of much lower temper. The end of this axle stub is turned taper and fitted to the casting portion. The hubs are preferably of a type having the ends threaded for dust caps.

(*To be continued.*)

From Professor to Student.

Suppose a pound of water at 32° F. to be converted into steam at 100lb. absolute. It could be made to raise a weight on increasing its volume while changing from the liquid state. At the end of this operation, the total energy of the working substance has been increased by 1,181.4 B.T.U., but, in addition, external work has been done, which seems totally unaccounted for.

Our correspondent's statement is not quite correct. The 1,181.4 B.T.U. does *not* represent the increase in the total energy of the working substance, but the sum of the increase of energy and the external work done during expansion. The increase of energy thus amounts to 1,181, *less* the equivalent, in B.T.U., of the work done during expansion. Since this work amounts to about 62,200ft. lb., which are equivalent to $\frac{62,200}{772} = 80.6$ B.T.U., the increase of energy is only $1,181.4 - 80.6 = 1,100.8$ B.T.U.

WIREMEN'S Electric Light & Power Wiring Section Artisans

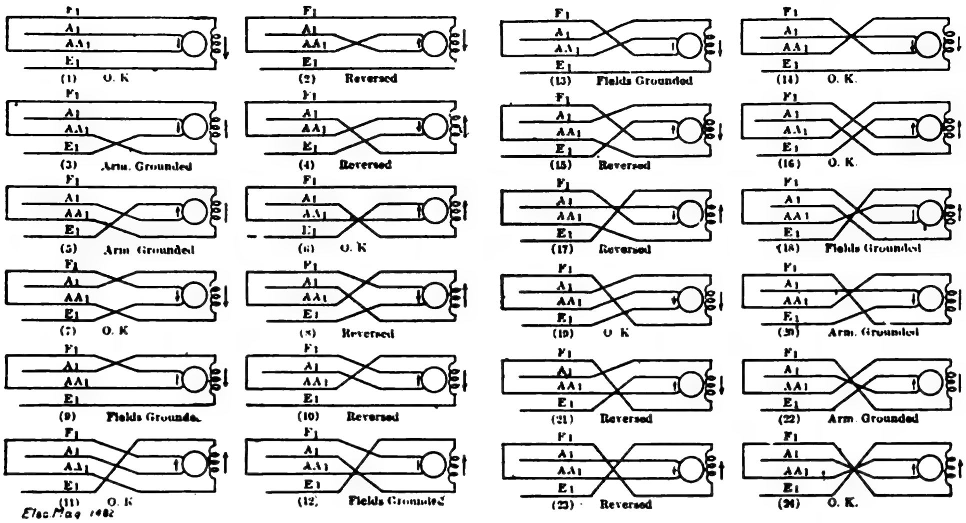
Wiremen and Artisans should refer to the World's Electrical Literature Section for classified list of articles on subjects of importance to themselves.

Mistakes in Motor Connections and their Effects.

By CALE GOUGH.

THE leads permanently attached to the motor and the motor leads of the car cables are usually marked with brass or fibre tags in such a manner that the proper connections may be made without difficulty. Often, however, the tags become lost, and in such an event the cables must either be rung out from the controller when the motor is connected, or the less certain cut-and-try method must be resorted to. The great number of wrong connections possible sometimes makes this latter method consume more time than would be required to test out the cables. A little reasoning from cause to effect, however, will usually make it possible to connect the leads properly on the second trial. The accompanying figures show all of the misconnections possible, together with the effects produced. Consecutive diagrams, as Figs. 1 and 2, 3, and 4, &c., show the connections for both the forward and rear positions of the reverse handle; that is, if Fig. 1 shows the connections with the reverse forward, the connections with the reverse to the rear are shown in Fig. 2, and *vice versâ.* The arrows indicate the relative directions of the current in the fields and armature. With both arrows pointing in the same direction as in Fig. 1, a forward direction of rotation of the motors is assumed. Arrows pointing in the opposite directions indicate that the motor is reversed.

In all there are twenty-four different possible connections of No. 1 motor leads. The fact that one of the field leads of No. 2 motor is usually grounded direct on the shell of the motor limits the number of possible connections of its leads to six. Fig. 1 shows the proper connections of No. 1 motor; Fig. 2 shows the armature leads reversed, which mistake simply results in a reversal of the direction of rotation of the motor. An interchange of the leads AA1 and E1, Fig 3, is made evident by the fact that with the reverse lever in the forward position the motor refuses to pull on the series points, and when the motors are thrown into multiple the fuse is blown or the breaker opens. These effects are due to the fact that the armature is grounded, the fields being short-circuited. The fact that when the reverse is thrown to the rear the motor tends to operate in a reverse direction distinguishes this misconnection from those shown in Figs. 5 and 20. There is, however, no way of distinguishing, by the action of the motor, this crossing of the lead AA1 and E1, from the very complicated crossing of connections shown in Fig. 22. In either case the armature is grounded with the reverse forward and throwing the reverse to the rear reverses the motor. In the same way the connections shown in Figs. 4 and 21 cannot be distinguished from each other. The connections indicated in Figs. 5, 6, 19, and 20, may be recognised by the fact that the armature is grounded for one position of the reverse handle while the motor operates in the proper direction when the reverse is thrown. Figs. 7, 16, and 24 show connections



THESE DIAGRAMS ARE NUMBERED BELOW WITH THEIR CORRECT FIGURES AS INDICATED IN THE TEXT.

permitting the motor to operate properly. It may be noted that in Figs. 7 and 16 the fields are placed in the circuit on the trolley side of the armature. The connections shown in Fig. 7 are often used by those who believe, for various reasons, that the fields should be placed in circuit on the trolley side of the armature.

Four connections, Figs. 9, 12, 13, and 18, give grounded fields and short-circuited armatures. Such connections would cause the motor to act as a generator, being dragged by No. 2 motor. Two of these connections, as in the case of those causing grounded armatures, give forward direction of the car when the reverse is thrown to the rear, while the remaining two cause No. 1 motor to oppose No. 2 motor.

In general the possible connections may be divided into three distinct groups: (1) Those giving forward and reverse direction of rotation of the motor with different positions of the reverse handle; (2) those by which the armature is grounded with one of the other positions of the reverse handle; and (3) those by which the fields are grounded with one or the other positions of the reverse handle. Those of the first class cannot be distinguished from each other by the action of the motor. However, should the motor operate in a direction opposite to that corresponding to the position of the reverse handle, the fault may be corrected by simply interchanging the armature leads of the motor. The connections of class two and class three are distinguished from each other by the fact that in one case the motor exerts no torque when the controller handle is in the series position and the reverse is thrown in one or the other direction, while in the other case the short-circuited armature causes the motor to act as a generator retarding the movement of the car. The different connections in these two classes may be further identified by noting the position of the reverse handle when the motors operate, and by this means the mistake may be recognised as being due to one or the other of two possible connections.

The only possible connections of the leads of No. 2 motor when the fields are grounded direct on the shell are those shown in Figs. 1, 2, 9, 10, 13, and 14. All of these may be definitely identified at once by observing the action of the motor and the position of the reverse handle. It cannot, of course, be presumed that the car house man becomes so familiar with the several misconnections and their effects as to recognise at once the proper changes to be made. Rather than spend so much time in studying possible mistakes it would be more economical and more satisfactory in general to keep the leads properly marked and thus avoid mistakes.—*Street Railway Journal.*

Emergency Lighting.

THE following particulars, taken from the *American Electrician*, will doubtless interest our wiremen readers. The method suggested, though not generally applicable, may prove useful for application in a modified form in special cases.

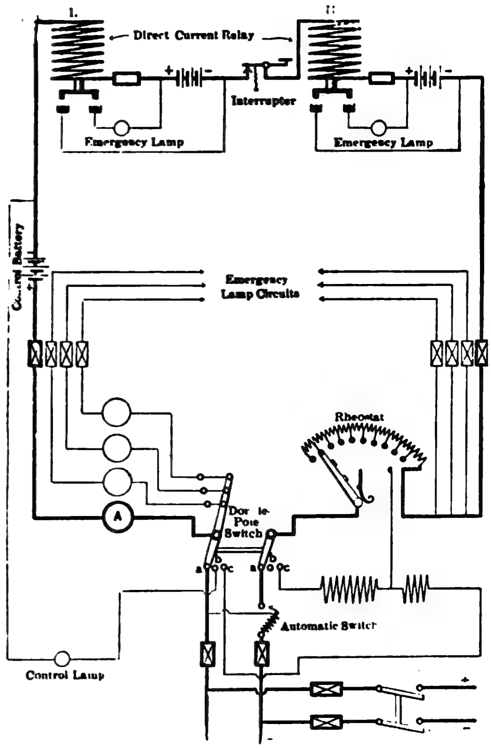


FIG. 1. DIAGRAM OF CONNECTIONS.

"A system of emergency lighting for use in theatres and other buildings has been devised by Prof. Hochenegg, as shown diagrammatically by Fig. 1 herewith. For simplicity's sake only one group has been represented in the diagram with two individual devices. Each of these includes a direct-current relay, the armature of which carries a metal bow, which, when the armature is released, completes the circuit between the emergency lamp and its battery, consisting of three cells connected in series. In place of one emergency lamp two lamps in parallel could be used, so that a sufficient amount of light will be obtained in the event of one lamp failing. These lamps are designed for an E.M.F. of six volts and consume about one ampere. The relays, batteries, &c., are all connected in series by the two heavy outer wires, which terminate in a double-pole switch. If the levers of the latter are placed on *a*, current from the mains will traverse the conductors, relays, and batteries of the emergency apparatus. So long as the intensity of the current in each group is above ½ ampere the armatures of the relays are held out of contact with the emergency lamp circuits. As soon, however, as the current falls below this amount, the relay armatures drop, closing the circuits of the emergency lamps. In order to again lift the relay armatures it is necessary to bring the current up temporarily to at least 2.5 amperes.

"The current is controlled by a rheostat, which is graduated so that the current in a given group of lamps cannot reach the limit of 2.5 amperes per group so long as the lever does not impinge against the spiral spring. A current in excess of two amperes can only be obtained by moving the lever against the pressure of the spiral spring, thus lowering the resistance. As soon, however, as the lever is released, the spiral spring throws it back to its contact limit, thus causing the current in each group to drop below 2.5 amperes.

"It is evident from the foregoing that the lamps of a given group are readily lighted by interrupting for a short time the circuit of the group in question at any given point. This is effected by interrupters placed at convenient places in the theatre In order to light the emergency lamps of all the groups simultaneously, the current supplied from the mains should be interrupted temporarily or permanently by moving the switch from the contacts, a. As a possible disturbance in the mains would result in the emergency system being switched out of circuit, the switch could be placed in the central position, *b*, during the time the emergency lamps are operated. The control lamp is then lighted as long as the switch is in this position.

"In order to cut the lighting system out of circuit, a sufficiently strong current impulse for each group of lamps should be thrown on the conductors, thus attracting the relay armature and cutting out the emergency lights. This result is obtained by placing the switch on the contacts, a, and throwing over the lever of the rheostat against the spiral spring until the current intensity of 2.5 amperes or more is indicated on the ammeter, A. The batteries for the emergency

lights are thus charged automatically, the current being adjusted by means of the rheostat. The second resistance shown is intended for allowing the lighting system to be switched off in case of failure of the circuit. The following advantages are claimed for the system: Each individual emergency lamp, having its own battery, is self-contained and independent of the main lighting system; all the emergency lamps can be inserted simultaneously from one point in the event of a sudden outbreak of fire, while several groups of lamps can be put in circuit independently by means of special switches; any disturbance in the conductor system, due to fire, water, &c., will cause the emergency lights to operate; the total number of emergency lamps can be switched out from one point and the recharging of the batteries occurs automatically as soon as the lamps are switched out; the batteries need not be removed.

Practical Questions and Answers.

At the Canadian Electrical Association convention at Montreal, many of the questions asked and answered in the question box were of a most practical kind. There were eighty-three in all, so that it is impossible to give more than a few of the entire number.

Starting Torque.

Q.—What is understood by the "starting torque" of a motor?

A.—By the starting torque is meant the force which the motor will exert at the rim of its pulley at starting. This force is usually expressed in pounds pull at one foot radius; thus if the radius of the pulley is less than 12in., the pounds effort which would be exerted at its rim would be directly proportional to the ratio of its radius to 12in. A simple definition of starting torque might be expressed as the pull in pounds which the motor will exert upon a rope fastened to the rim of the pulley and secured to a stationary body.—R. T. MacKeen, Toronto.

Cleaning Wire.

Q.—What is the best method of cleaning joints on a transmission line preparatory to soldering them? The line is a bare one and has been up for some years, but the joints were never soldered.

A.—Under the conditions mentioned, the only proper way seems to be to cut out joints and put in new ones, or put in jumpers soldered on either side of the old joint. Cleaning with zinc and sulphuric acid is effective, but the corrosion due to the acid not evaporated by the solder remaining in the joint makes it bad.—J. F. H. Wyse, Toronto.

Solid Wire v. Hemp Cord.

Q.—Why is a transmission cable made of six wires over a hemp centre preferred by some engineers to all-copper cable?

A.—The use of a copper wire cable for a copper cable is very objectionable, due to the fact that the moment any strain comes on the cable this strain is assumed almost entirely by the copper wire centre, with the result that it is elongated to a point where the cross-section and strength are materially reduced, or, in some cases, until rupture occurs. This is due to the fact that the outer conductors of the cable are wound spirally, and hence possess in a measure the properties of a spring. The result is that it can be elongated very much more upon the application of tension than is possible with the solid conductor. A hemp centre is more elastic, and hence is free from the objections of the solid wire centre, and apart from the question of conductivity furnishes a substantial core upon which to wind the cable. It is also of considerable strength, and doubtless adds materially to the total strength of the cable. In this case, however, the whole tension is practically taken by the copper conductors.—R. T. MacKeen, Toronto.

Compressed Air for Cleaning.

Q.—(a) Is it advisable to use compressed air to clean dynamos, &c., in a central station? (b) At what pressure? (c) Has the suction method used in house cleaning ever been tried on dynamos? (d) Would it not prevent raising dust through the air to fall later on the dynamos?

A.—(a) Yes, in every instance when possible. (b) At 50lb. per square inch. (c) Not to my knowledge. (d) An excellent idea, and would prevent the dust falling back on machines, but would not reach the distances in small places, for instance between the armature and field coils or pole pieces, like an air blast.—J. F. H. Wyse, Toronto.—*Canadian Machinery.*

An Electrical Repair.

This particular armature had already done lots of good work in its time, and electrically speaking was in good condition. It was of the engine type, that is to say, it allowed its shaft being withdrawn without in any way interfering with the relative position of the commutator to the winding. Originally the keys had been of a badly fitting character and the spider itself must have been a bare sliding fit on the shaft instead of a press fit as is usual in such cases. As a result the armature had gradually worked loose on its shaft, which had become slightly grooved. It was decided to re-bore the spider and make a new shaft, and the order was given that it was to be a shrink fit. This at first sounded rather alarming, for we felt rather dubious over the shrinking part of the job, but the matter was gone into seriously and it was decided that we could make a job of it.

The first operation was to fix up the job on the table of the horizontal boring machine, and this had to be done nicely so as to allow of its being truly bored. It was set from the commutator face, which had been newly turned up, and from certain machine marks at the rear end of the spider. After boring, the keyways were cut, which was done by sliding the bar with a cutter and opening up the old keyways to respectable dimensions. This was a very tedious job and did not allow of any taper for top fit. The spider was 18in. internal diameter by 35in. deep. It was chambered out 15in., thus leaving two sleeves 10in. long at each end for fitting. The shaft was turned dead to standard gauge with a slight lead at the nose for insertion into the hub. This shaft also had a flange against which the spider hub fitted when in place, and it was necessary that it should fit tight against the face in order to allow the insertion of several bolts which played a part in the scheme. An allowance of 0.005in. was made for shrinkage and a pin gauge was made a full $\frac{1}{32}$in. large to gauge the expansion of the hub when hot.

The armature was set up over a pit, so that the shaft could be stepped vertically. By means of a cylindrical coil, spirally constructed and furnished with gas and air blast, the hub was made hot. The winding was carefully insulated from heat influence by means of asbestos, and in due time the eye had expanded sufficiently to allow the insertion of the pin gauge. In no hurry, the hub was allowed to soak a little longer while attention was paid to the shaft, which was suspended vertically from the crane, ready to be lowered at the proper moment. This ready, the burner was withdrawn, the shaft let in up to the flange, and arrangements immediately made for cooling off. Now the point to cool off first was undoubtedly that near the flange, for if the opposite end seized and contraction set in, then a space would be left at the flange end, and an unsatisfactory job be the result. So particular attention was paid to that part, and, under the influence of a judicious supply of water, the job was properly cooled off and placed in the lathe for testing. We found the commutator was just $\frac{1}{64}$in. out of truth.—*Machinery*, N.Y.

Main Fuses.

We have had some trouble of late with a 220 volt direct current circuit carrying some 600 to 800 amperes. The fuses were of the ordinary link variety, and were used two in parallel on each circuit. Each fuse was supposed to blow at 400 amperes, or 800 amperes for the pair. However, the contacts were small and generated considerable heat, so that a load of 600 amperes would open the circuit, if continued for any length of time. The blowing of the main fuse of itself was no serious matter, but owing to the cramped arrangement it was difficult to get new fuses in place, and the lights would be out for some time. We therefore had built a new arrangement of fuses mounted on a marble slab 12in. by 18in., and mounted the whole on brackets directly back of where the original fuses were. The panel is arranged for three fuses, the central one being the equaliser. The fuse-link itself consists of two copper plates about 3in. square by $\frac{1}{4}$in. thick, and connected together by two strips of fuse-metal soldered on. The clips into which the copper plates of the fuse-links fit were originally made for a three-pole double-throw switch, and were therefore easily obtained. The contact surface is ample, and the fuses don't heat unless the load gets near the point at which they should blow. Another advantage is that in case the fuses do blow, it is but an instant's work to slip out the copper plates of the old fuse and insert a new one, several of which are kept on hand.—*Power*.

You should carefully study this Section, as it will save you much valuable time. It is the key to the world's monthly Electric Progress.

Power.

Articles.

A Norwegian Hydro-Electric Plant. C. Smith. — *Elec. Wld. & Engr.* 22/7/05.
Electric Power Developments at Portland, Oregon. — *Elec. Wld. & Engr.* 29/7/05.
Hydro-Electric Developments in Norway. L. Ramakers. — *Amer. Elec.* Aug./05.
*Application of Electric Power to Auxiliary Machinery in the Navy. L. C. Brook. — *Amer. Elec.* Aug./05.
Electrically Released Brakes on Cranes. A. B. Weekes. — *Amer. Elec.* Aug./05.
The New Turbine Station of the Boston Edison Electric Illuminating Co. — *Power.* July/05.
A 10,000h.p. Steam Turbine. F. Koester. — *Power.* July/05.
*The Bursting Strength of Wooden Pulleys. C. H. Benjamin. — *Machinery, N.Y.* Aug./05.
Variable Speed Mechanisms. — *Machinery, N.Y.* Aug./05.
Electric Winding. J. G. Hooghwinkel. — *Elec. Power.* Aug./05.

Traction.

Articles.

Novel A.C. Block Signalling. C. A. Bennett. — *Strt. Rly. Jrnl.* 15/7/05.
New Car Shops and Houses for the New Jersey Corporation. — *Strt. Rly. Jrnl.* 22/7/05.
The Prevention of Overhead Accidents. R. N. Tweedie. — *Elec. Rev.* 11/8/05.
New Electric Locomotives for the Valtellina Railway. B. Valatin. — *Strt. Rly. Jrnl.* 5/8/05.
*Experiments on the Valtellina Road. F. Koester. — *Elec. Rev., N.Y.* 15/7/05.
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*Telephone Construction Practice. H. J. Minhinnick. — *Telephony.* Aug./05.
Concerning Telephone Traffic. S. G. McMeen. — *Telephony.* July/05.
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Special Information by Telephone. S. G. McMeen. — *Telephony.* Aug./05.
Sioux City New Automatic System. G. T Hewes. — *Telephony.* Aug./05.
Maintenance of Underground Structures. J. M. Humiston. — *Telephony.* Aug./05.

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Works of the Electrolytic Alkali Co. at Middlewich. J. B. C. Kershaw. — *Elec. Wld. & Engr.* 15/7/05.
The D'Arsonval Fulmen Storage Battery. — *Elec. Wld. & Engr.* 15/7/05.

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The Rapid Electro-Deposition of Carbon. S. Cowper-Coles. — *Faraday Soc.* 3/7/05.
The Use of Balanced Electrodes. W. H. Gee. — *Faraday Soc.* 3/7/05.
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Electrolytic Analysis of Antimony. H. D. Law and F. M. Perkin. — *Faraday Soc.* 3/7/05.
Storage Batteries and their Electrolytes. R. M. Vickers. — *Faraday Soc.* 3/7/05.

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Articles.

Meteorology and the Dynamo. M. T. Cromack. — *Elec. Wld. & Engr.* 29/7/05.

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Heat Insulation, particularly with regard to Materials Used in Furnace Construction. J. S. Hutton and J. R. Beard. — *Faraday Soc.* 3/7/05.

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*Variation of Electrical Resistance in the Contact of Carbon and Cast-Iron. E. Schoenan. — *Elec. Wld. & Engr.* 15/7/05.
*Kinetic Variation of Pressure in Electric Generators. A. Russell. — *Electn.* 4/8/05.
A Study of Circuits Containing Resistances, Inductances, and Capacity by Means of the Circle Diagram. J. S. Dow and F. Creedy. — *Elec. Engr.* 4/8/

Central Station Practice.

Articles.

*Electricity Meters. C. H. W. Gerhardi. — *Electn.* 28/7/05.
Boiler Room Trouble. S. F. Henry. — *Amer. Electn.* Aug./05.
Suggestions Concerning Valves. W. H. Wakeman. — *Power.* July/05.
*Engine Room Chemistry. A. H. Gill. — *Power.* July/05.
New Forms of Flanged Pipe Connections for High Pressure Superheated Steam. L. D. Lovekin. — *Power.* July/05.

Students.

Articles.

*How to Make an Electric Buckboard. C. Brocksmith. — *Amer. Electn.* Aug./05.

Wiremen.

Papers.

Installing Electric Machinery. N. G. Meade. — *Power* July/05.

"Le Four Électrique."

("The Electric Furnace.") Part I. By ADOLPHE MINET. Paris : A. Hermann. 1905. Price fr. 4.

Several works have recently appeared on the Electric Furnace, and of these the present treatise promises to be one of the most comprehensive. The part under review deals with the gradual evolution of the electric furnace, and contains an interesting and copiously illustrated account of the various forms used at different times. Then follows a theoretical section containing an explanation of our present system of units, the laws of electrolysis, and the determination of E.M.F.'s. The work is embellished with a number of portraits of eminent investigators in the field of electro-chemistry. Highly commendable features of the work are the full bibliographical references. We await with interest the appearance of succeeding portions of the book.

Benson's "Facts for Advertisers," 1905-6.

London : S. H. Benson, 1, Tudor Street, E.C. Price 5s.

While commerce remains, advertising will live. Both must die together. At present both are desperately active, and advertising needs to be particularly so. Much publicity is sought by commercial concerns, and every large house now has its publication department; consequently, more directed effort characterises the affairs of these bureaux, but the sum total of these endeavours are as nothing compared to the purposeless, inane attempts of even reputed establishments to sound the praises of their goods in the public ear. Benson's "Facts" is the first organised attempt on British soil to bring together those who sell and those who buy, through channels cut by experience and by methods proved invaluable in the stern field of competition. To attempt even to abstract the contents of this handy pocket volume would be to do its publishers an injustice. Facts can't be narrowed down, and we must ask our interested readers to get them at first hand. The colour scheme of the book must be seen to be appreciated. It will save those valuable minutes we are now taught to prize. To the advertisement manager the work must come as a veritable El Dorado of information, and to the firms whose interests he serves it will bring home some hard advertising truths difficult to get away from.

"Electrical Instruments and Testing."

N. H. SCHNEIDER. 1905. London : E. and F. N. Spon, Ltd., 57, Haymarket Street, S.W. Price 4s. 6d.

It is generally supposed that students need to peruse in separate book form what might well serve as the introductory chapters of a large text-book. On the strength of this surmise, we think this little book might be useful to improvers, students, wiremen, and beginners in electrical work generally. Its price could, we think, with advantage have been lower, or perhaps we should say that the printing, paper, and illustrations are too good for the subject, and for the rough handling by zealous young readers which such volumes generally receive. The instruments referred to are mostly of American make, and will be found to possess modifications over the English patterns. The uses of the instruments and various formulæ are clearly explained: in fact, some of the descriptions contain confusing repetitions and advice of quite an extraneous character.

"Alternating Current Engineering."

By E. B. RAYMOND. 1904. New York : D. Van Nostrand Company ; London : Kegan Paul, Trench, Trübner and Co., Ltd., Gerrard Street, W.C. Price 16s.

Of new books on alternating currents there seems no end. Certainly no one specific branch of electrical engineering can have received more lavish attention at the hands of its partisans. Books on alternate currents seem to fall into classes, such as ultra-theory with calculus sauce in abundance, ultra-practice with plenty of engineering facts and data, and the elements of both these form the subjects of yet other classes. The present volume is a mixture of the last three of these classes. It is divided into two parts dealing respectively with the general subject of magnetism and alternating current apparatus. A considerable portion of the former might well have been omitted or condensed into about three dozen pages. Engineers are quite capable of absorbing elementary principles if placed before them in a terse, concise way, and do not relish labouring through the minutiæ of wordy explanations. The second half of the volume is worth careful perusal, as it clearly details the functions of modern alternating apparatus. Transformers, motors, and alternators all receive close attention, and are fully described with suitable diagrams. There are no illustrations of complete machines and apparatus, and these are preferably omitted as the text, if crowded with such views, becomes little better than a manufacturer's catalogue. The section on A.C. motors will bear close reading at the present time, when one-phase motors are likely to have an extensive use. In this respect the repulsion motor receives detailed notice. The

concluding chapter is on testing methods, and these are very exhaustively treated. Some eighteen different tests are described in detail, and with the explanatory diagrams the characteristics of an alternator can be readily obtained. To the designing engineer the second part of the volume should be distinctly valuable, as it has been prepared from data obtained at first hand at the designer's board and the works test plate. The author is on the testing staff of the General Electric Company at Schenectady. We notice that "victor" stands for "vector" as the headline on page 23, where it should have been at once noticed

"Elektrische Kraftübertragung."

("Electric Power Transmission.") By W. PHILIPPI. Leipzig: S. Hirzel. 1905. Price M.16.

In this treatise the author deals, from a general standpoint, with the subject of electric power transmission. In order, however, to enable engineers who have not made a special study of electrical matters to follow the principles which determine the choice of the most suitable system under given conditions, the author gives a brief account, in Part I. of the book, of such introductory matters as electrical units, generators, motors, transformers, secondary cells, &c. Part II. deals with the general principles underlying the design of generating stations, switchgear, parallel running, feeders and distributing networks, substations, motor starters, &c. Part III. is devoted to electric lifts and cranes. Part IV. deals with the applications of electric power in mining—including the driving of various forms of drilling, cutting, ventilating and pumping machinery, and haulage. Part V., which is contributed by Dr. G. Meyer, deals with the var'ous applications of the electric motor in connection with blast-furnace work and rolling mills. In Part VI., which concludes the work, are considered various other applications, such as machine tool driving and the driving of paper-making, textile and agricultural machinery.

In view of the vast extent of the subjects dealt with, it was, of course, not to be expected that details of construction would be fully considered. On the other hand, the elements of the rational design of an electric drive are dealt with thoroughly and clearly in each case, the advantages and disadvantages of the various methods available being critically examined. On the whole, the work is one which fills a decided gap, and contains a large amount of technically sound and useful information.

"Modern Electric Practice."

Edited by MAGNUS MACLEAN, M.A., D.Sc. Vol. V. London: The Gresham Publishing Company, Southampton Street, Strand. Price 9s.

Several months have elapsed since we reviewed the earlier volumes of this useful work. We now turn to one of the two concluding volumes, the last and sixth of which has only recently been published. Vol. V. opens Section V. of the series, this being devoted to boilers and prime movers, with auxiliary plant. Mr. J. K. Stothert is the author of the Boiler Division of the section, and he has covered the ground very well. The first eight chapters absorb much valuable space in describing the chief boilers now commonly used. Superheating, combustion and evaporation, and the testing of boilers are treated rather scantily in three chapters, which might with advantage have been longer. The data given is, however, very useful, and will be found valuable to central station engineers. In the second division, Mr. H. O. Beckh deals with steam engines and other prime movers. Far too much space has been allotted to the subject of reciprocating engines, no less than twenty-four pages being given over to a theoretical consideration of fly-wheels for such engines. The case of steam consumption receives adequate and proportionate attention in the succeeding chapter, and various types of engines are there described. Steam turbines receive but cursory consideration, which is, to say the least, unfortunate in view of the title of the work. The vertical turbine is ignored entirely, and the whole subject is dismissed in ten pages. We are glad to see that the gas engine escapes this summary treatment, and is dealt with more at length in the concluding chapters of the section. In our copy, Fig. 1,344 is entitled a gas engine generator, whereas the subject is so obviously a governor that the error is the more singular. Mr. W. H. Booth, who handles the subject of condensing and auxiliary plant in his customary fluent style, makes a plain case of the subject without undue elaboration. In five chapters he takes up the subjects of condensers, air pumps, economisers, and feed heaters, water cooling, and feed pumps, and gives enough practical information interspersed with details of the principles involved to justify its careful perusal by the average engineer in charge of such plant. Section V. classifies several of the minor applications of electricity and commences with electro-chemistry and electro-metallurgy by Dr. J. Shields, who briefly surveys the position of this industry and describes the principal processes and apparatus.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

Furnace Control.

THE present article deals with the important question of automatic apparatus for indicating and registering the composition of the waste gases from steam boiler furnaces. In face of the ever-increasing intensity of competition in all industries, it is becoming more and more necessary to reduce where possible the costs of manufacture, and since power is one of these, the question of reducing its cost is of great importance. To effect economies in the cost of power derived from steam generators, it is necessary to have efficient and continuous control over the fuel combustion. The determining factor which gives a reliable indication of the good or bad condition of combustion is the percentage of carbon dioxide contained in the gases passing away from the furnaces.

There have been numerous attempts in the past to devise apparatus for this purpose. The results attained until recently have been of somewhat doubtful value, owing in great measure to the complicated character of some of the earlier instruments, these in some cases necessitating drying the gases by passing them through vessels containing calcium chloride. Later apparatus worked on the well-known principle that a solution of caustic potash or soda very readily absorbs CO_2 gas. Apparatus, however, which depend upon this principle are liable to give unreliable results, since the solution after repeated absorptions naturally loses its capacity for entirely depriving the flue gases of their CO_2. Consequently, unless great care is exercised and the solution frequently renewed, the required consistency in the records obtained is wanting.

An apparatus whose method of working does not depend upon chemical absorption is now, however, available, and it is the intention of this article to describe this recorder, now well known as the "Krell" Automatic CO_2 Recorder. The principle upon which the recorder works will be clear from an inspection of the illustrations. Fig. 1 is a diagram showing the mode of action; Fig. 4 a view of the complete apparatus, from which it will be apparent how compact and simple it is. The actual floor-space required for the instrument itself is only about 2ft. 10in. by 1ft. 6in., and the height about 6ft.

The apparatus consists of two principal parts, namely, the system of tubes and the pressure gauge or differential manometer. The tube system consists of two brass tubes (*a* and *b*) about 1¼in. diameter surrounded by a metal casing. The tubes are about 5ft. 9in. high, and are joined together at the top (*x*). At this point a ½in. tube is connected and bent downwards and led to the ejector. This tube is provided with a small gauge (*j*) and the shut-off cock (*h*). The former serves for indicating and the latter for entirely shutting off the suction. The tubes (*a* and *b*) have at their lower ends the cocks, *f*, *l*, *v*, *e*, *k*, and *w* respectively. The cocks (*l* and *k*) are coupled together by a rod so that they can be worked simultaneously.

When the ejector is set to work the flue gases are drawn from the boiler flues through the tube (*d*) and cock (*f*) into the vertical tube (*a*), and at the same time air is drawn through the cock (*e*) into the tube (*b*). Both the gas and the air, which have different

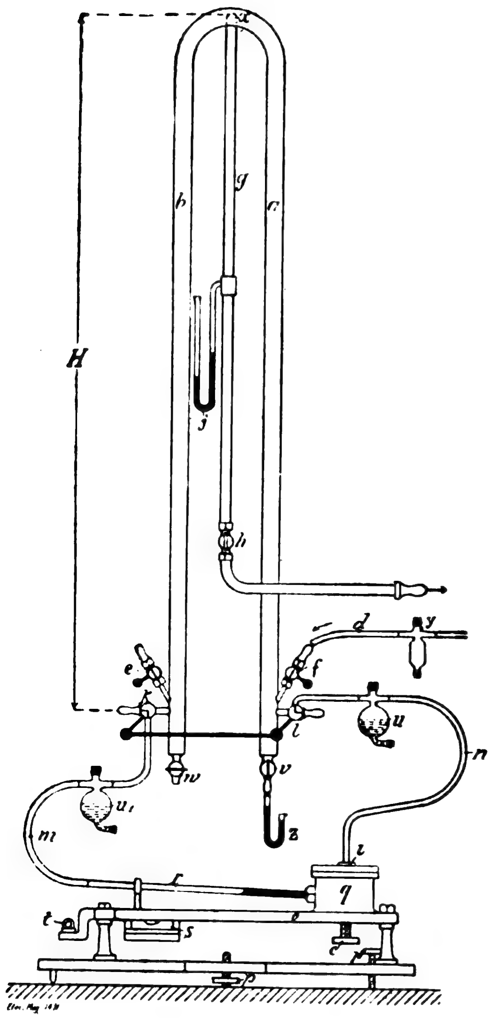


FIG. 1. DIAGRAM OF WORKING PARTS. "KRELL" RECORDER.

specific gravities, are drawn upwards and pass out at (*x*) through the tube (*g*) to the chimney. By this means we get two columns, one of flue gas and the other of air, of equal height (H), whose difference in weight varies according to the quantity of CO_2 in the column of flue gas. Since the weight of (*b*) remains the same, and that of (*a*) depends upon the proportion of CO_2, the difference in weight at any time may be used for directly determining the percentage of CO_2 in the furnace gases. For this purpose the two columns are put into connection with the differential pressure gauge.

The pressure gauge consists of a plate (*o*), with the box (*q*) cast in one with it. Securely fixed in the side of this box is the glass tube (*r*), the other end of which rests in, and is supported by, a small bracket. By means of the set screws (*p* and *p*) and the levels (*s* and *t*), the pressure gauge and its graduated tube (*r*) are set in the correct position. An indicating fluid is put into the box (*q*) through (*i*) until it reaches the zero point of the scale alongside the graduated tube. The tube is graduated to show percentages of CO_2. If the rod connecting the three way cocks (*l* and *k*), shown in the figure to the left, be put over to the right, the columns (*a* and *b*) will be connected with the pressure gauge described, thereby causing the measuring fluid to be forced along the graduated tube. The extent of this movement corresponds with the percentage of CO_2 in the column of gas (*a*), and may be directly read off. Since the flue gases are continually passing through the apparatus, the changing percentage of CO_2 may be noted by the corresponding position of the measuring fluid, and consequently the percentage of CO_2 may be ascertained at any moment.

The connecting tubes (*m* and *n*) are provided with small glass vessels (*u* and u_1) containing pure alcohol, which, by its own evaporation, prevents the alcohol in the pressure gauge evaporating. The cocks (*v* and *w*) are draw-off cocks; the former is always left open and is connected by a rubber sleeve to a water syphon (*z*) hanging beneath, which serves for the purpose of collecting any water of condensation from the flue-gases and discharging it. The latter is for testing purposes.

The pressure gauge (Fig. 1), as previously mentioned, consists of a narrow horizontal plate with a closed box (6)—see Fig. 2 for description following—cast on the top, which is covered with felt to protect it against sudden variations of temperature. The top of the box is connected with the tube (*a*) containing the flue gas and the bottom through the graduated tube (9), which dips beneath the surface of the registering fluid contained in the box (6) with the tube (*b*) containing the air. Into the left-hand side of the box is fixed the glass graduated tube (9), supported at the other end in a small bracket (10). At the left-hand end in front of the plate (5), levels 11 and 12 are fixed. The graduated tube is divided by black strokes; with the zero point to the right up to 18 towards the left, each division indicates 1 per cent. of CO_2. A lamp bracket (Fig. 2) is

secured to the base, and carries a cylindrical glow lamp or other steady illuminant. Below the lamp is a small asbestos screen with a slit through which the rays of light fall upon a mirror (20), fixed at an inclination of 45 degrees behind the graduated tube (9), which reflects them horizontally through the graduated tube and into the recording camera.

The side of the camera is provided with a door, hinged at the bottom and secured by a catch at the top, which entirely prevents entrance of light to the camera. At the opposite side of the camera is a hole to receive the axle of the clockwork, which is firmly secured by means of the milled head (27). The clockwork rotates a brass drum inside the camera once in twenty-four hours. Fig. 4 shows a side view of the camera, with the timing-ring about ¾in. wide, with divisions from one to twelve hours by quarter-hours. The recording chart is placed round the drum and revolves with it. At the side of the opening in the camera, and at the right hand side of the timing-ring there is an index mark upon a hinged plate, by means of which the revolving cylinder can be set to any desired starting time. The clockwork is wound up by rotating the cylinder inside the camera in the clockwise direction. The camera is provided with a handle on the top, by means of which it may be easily carried.

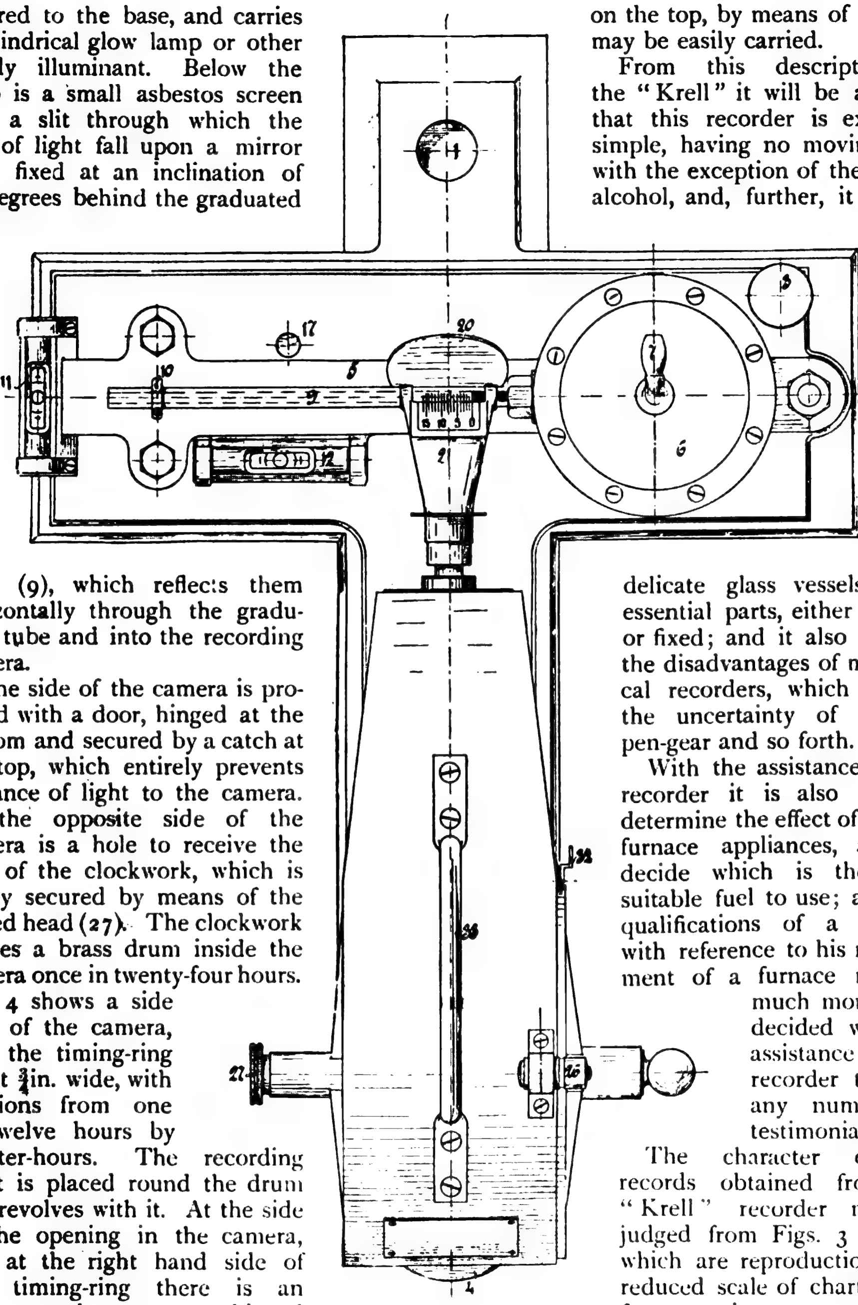
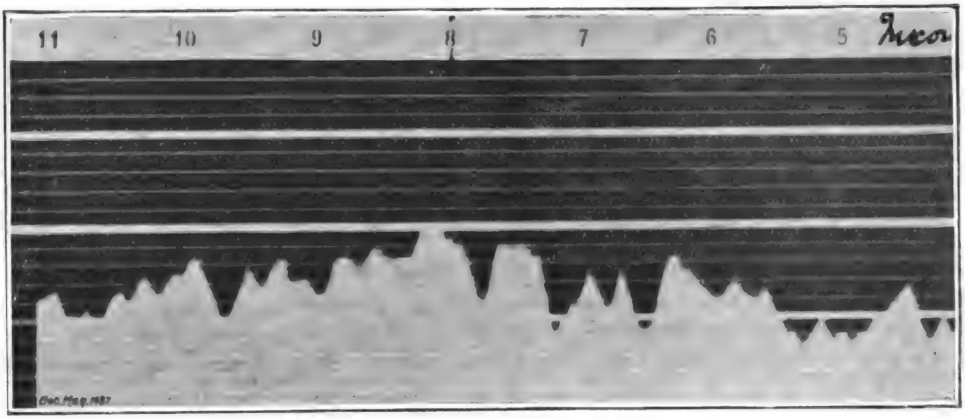


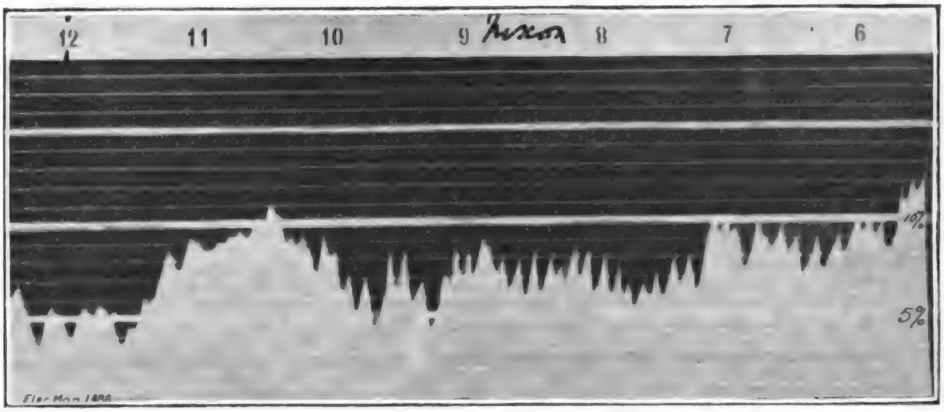
Fig. 2. Plan View of "Krell" Recorder.

From this description of the "Krell" it will be apparent that this recorder is extremely simple, having no moving parts with the exception of the mobile alcohol, and, further, it has no delicate glass vessels in its essential parts, either moving or fixed; and it also has not the disadvantages of mechanical recorders, which involve the uncertainty of delicate pen-gear and so forth.

With the assistance of the recorder it is also easy to determine the effect of various furnace appliances, and to decide which is the most suitable fuel to use; also, the qualifications of a fireman with reference to his management of a furnace may be much more easily decided with the assistance of the recorder than by any number of testimonials.

The character of the records obtained from the "Krell" recorder may be judged from Figs. 3 and 3A, which are reproductions on a reduced scale of charts taken from an instrument working at one of the numerous large generating stations in the provinces which are provided with "Krell" recorders. An actual chart representing twenty-four hours' combustion is about 21in. long and 3in. deep, and, as will be





FIGS. 3 AND 3A. VIEWS OF RECORDS AS MADE OFF "KRELL" RECORDER.

observed from the reduced facsimiles, the hour figures and the percentage lines are printed by the instrument itself, thus obviating the delay and liability to error when it is necessary to fix the paper to a certain zero line or mark. Provided the paper is slipped on to the revolving drum shown in Fig. 2, and the particular starting hour marked on the rim of the drum set against the hinged pointer, the resulting chart will show an absolutely reliable record as regards both time of formation and the amount of CO_2 in the flue gases being tested. In practice it is found that the CO_2 percentage read off from the graduated tube (see 9, Fig. 4) is practically simultaneous with its formation in the furnace, and consequently the "Krell" is of real practical use to the engineer and the fireman, as steps can instantly be taken to improve the combustion by altering the position of the dampers, thickness of fires, &c. The first diagram, Fig. 3, was taken shortly after the apparatus was set to work, and shows on the average a poor percentage of CO_2. Measures were then taken to improve the conditions by stopping previously unsuspected air leakages in the boiler settings, around the damper openings, chain holes, &c., and the stokers were instructed as to the best method of working their fires, and how to properly regulate the draught to the requirements of the various rates of combustion. A bonus was also later arranged so that the firemen had a direct incentive to do their work efficiently. The chart, Fig. 3A, taken from the recorder shows clearly the advantages which accrued from the steps taken to effect an improvement in the conditions, the difference in efficiency representing practically a 5 per cent. saving in fuel for the same amount of work from the boilers. With regard to the

accuracy of the records obtained from the "Krell" recorder the following comparative readings are instructive. The tests were made by means of direct chemical comparison with an Orsat set:

(*a*) Mean of 120 readings from "Krell," taken every half minute from tube 9: CO_2 = 12.3 per cent. (*b*) Mean of twenty-nine analyses with Orsat = 12.2 per cent. (*c*) Mean height of "Krell" chart equivalent to 12.5 per cent. Another test at the same station gave 9.9 and 9.7 per cent. The duration of both the above sets of comparative tests was one hour.

Another test carried out by the electrical engineer to a Borough Council in the North-West London district, extending over one and a half hours, gave results "Krell" 14.1, chart 14.1, and Orsat 14.4 respectively.

The recorder here described, although designed upon true scientific lines, and being used to indicate very small differences of pressure, is very substantially made and may be put up in any suitable situation in the power house, preferably so placed as to be readily accessible by the firemen themselves, who, experience shows, soon take an intelligent interest in its indications, at all times available for their guidance, the usual plan adopted being to provide a small inspection eye, closed by a drop lid or slide, in the side of the wood cabinet with which the recorder is generally surrounded to protect it from injury and to keep it clean. This cabinet may be made to serve as a dark room in which to develop the daily chart, thus obviating the necessity of removing the camera portion, shown provided with a handle on the top in Fig. 2, to a suitable place for the purpose of developing and fixing the chart.

In conclusion, it may be said that the cost of the apparatus is very reasonable when due consideration is given to the manifest advantage of being able to continuously ascertain the conditions of combustion in the furnace.

The Krell recorder is supplied by The Smoke Preventer Co., Ltd., whose head office is at Blackburn, with branches at London, Glasgow, Birmingham, &c.

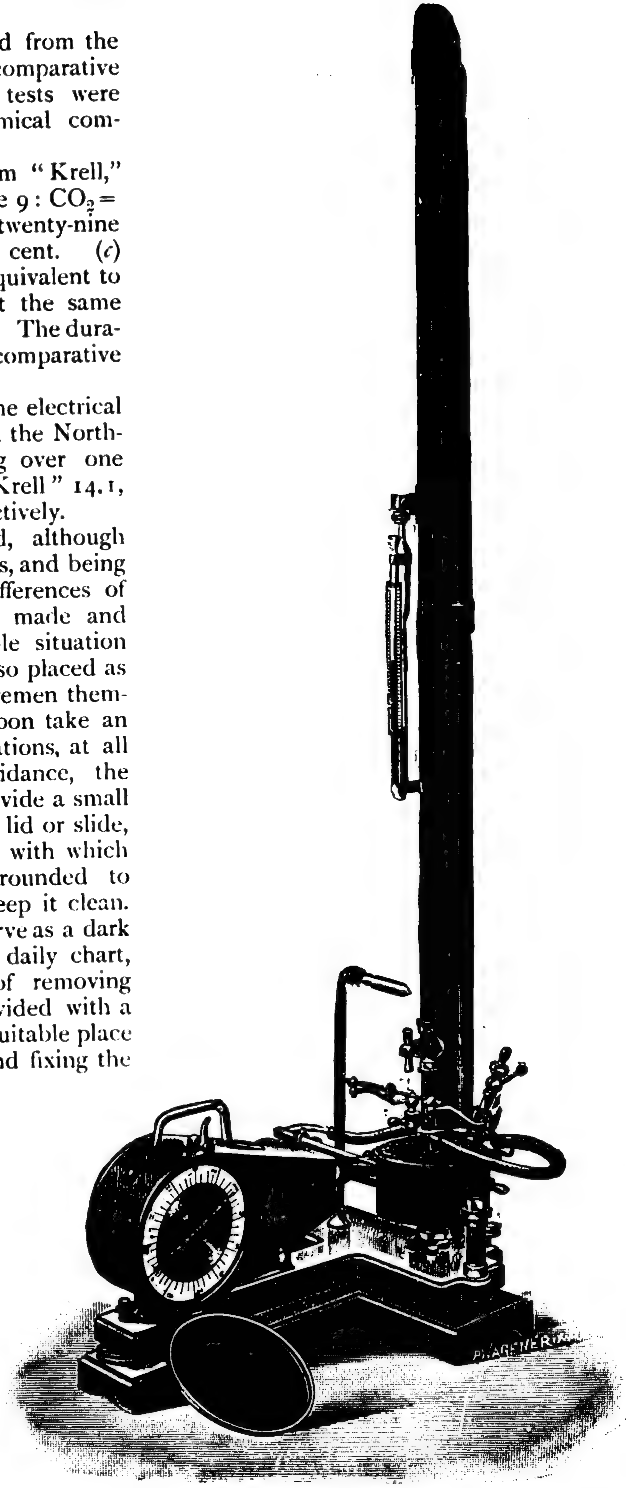


Fig. 4. Complete View of "Krell" CO_2 Recorder.

KRIÉGER ELECTRIC CARRIAGES.

THE success obtained by the Kriéger carriage in England and on the Continent has placed it in the front rank of electric automobiles. The distance it is able to travel without recharging is more than sufficient for the daily requirements either of business or private users. This capacity varies between from about 40 miles to 105 miles, according to the type of vehicle.

The superiority of the Kriéger carriage has been proved by experience and demonstrated in competitions, and it is commendable equally for its remarkable elegance, its comfort, its security, reliability, and economy. It is, in short, of the greatest utility either for private or public service, for delivery vans, omnibuses, &c., &c.

Each of the front wheels is driven by a separate motor, supported on a swinging arm, the bearing of which coincides with that of the wheel, each motor being suspended by a very flexible spring fixed to the wheel axle. This method of suspension gives an easy drive and does away with all shocks in starting and stopping, and greatly lessens the wear of the mechanism. The motor is entirely enclosed and is completely shielded from dust, mud, and damp. The commutator and the brushes are quite accessible. Each motor is individually removable and interchangeable in a short space of time.

A pinion keyed to the spindle of each motor gears directly with a toothed steel wheel fixed concentrically around the hubs of the driving wheels. The fibre teeth of the pinions give a perfectly noiseless drive.

This direct transmission gives a very high efficiency by its simplicity alone. The number of pieces requiring to be renewed after use are reduced to a minimum, and the charges for the upkeep of the mechanism are insignificant.

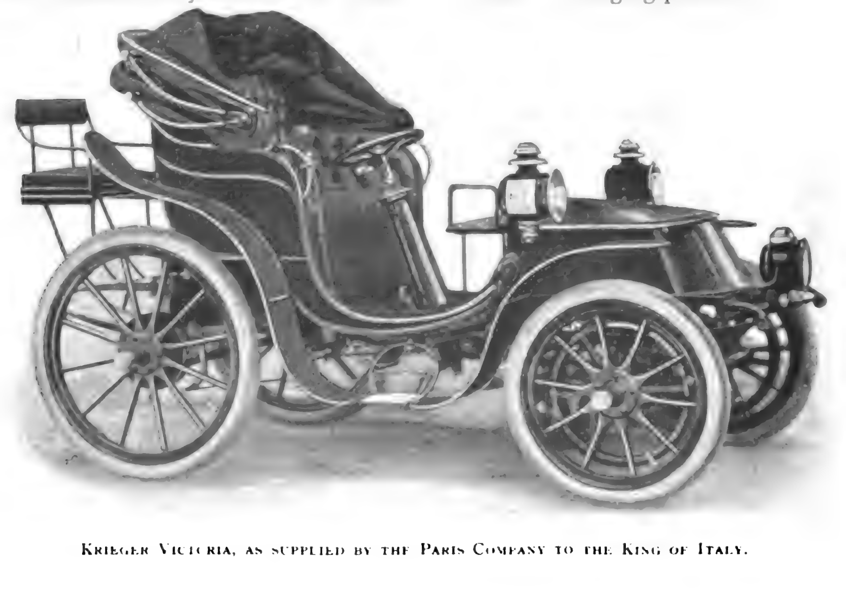
The whole of the wiring for the motors, controllers, &c., are highly insulated, and so placed so as to be accessible throughout their entire length. The connections are made by fixed terminals with nuts and lock-nuts, which ensure good contact and insulation, and also permit rapid changes of the whole or part of the wiring.

On descending a hill, the momentum of the car rotates the motor armatures; the current generated thereby is utilised for recharging the batteries, effecting a very considerable economy, by utilising the power that would otherwise be uselessly expended in heat were an ordinary brake employed.

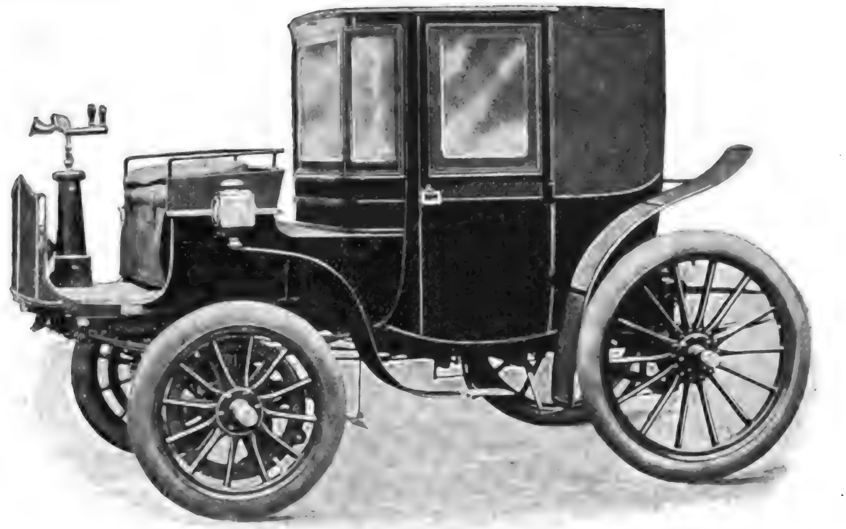
The controller is below the steering handle and is easily manipulated. It is of solid construction although contained in a small compass.

It permits of a number of combinations sufficient for all the requirements of the road, ensuring to the vehicle a perfect economy in working.

Reverse movement.
Electric brake.
Zero. Charging position.



KRIEGER VICTORIA, AS SUPPLIED BY THE PARIS COMPANY TO THE KING OF ITALY.



KRIÉGER LANDAULET CLOSED.

Starting.

Slow speed.

Recuperation at 40 volts.

Normal speed on the level, or on a medium hill.

Recuperation at 80 volts.

High speeds or normal with a low charge.

The contact fingers are easily removable and replaceable. Their cleaning and that of the contacts is very easy, the controller being enclosed in a plain cylindrical case in two halves, which can be completely opened.

The accumulators are enclosed in one or two boxes of hard wood, acid proof and iron clamped; they are provided with the necessary means for removing them easily. The vehicles are so arranged as to conveniently receive any known make of accumulator.

The steering is very simple, and is geared down in the ratio of 1 to 4, which makes it very smooth, and can be fitted either with a wheel or handle-bar. All the wearing parts are of the finest material and workmanship, and, having been standardised at great expense, are interchangeable throughout, so that no time need be lost in repairs.

The vehicle is provided with three brakes, *viz.* :—1. The recuperation, which permits the rapid slowing-down of the carriage, and gives a continuous brake on descending a hill. 2. An electric brake acting on the front wheels. 3. A mechanical brake acting on the back wheels, in either direction. The last two are instantaneous in action.

The framework of the vehicle, constructed entirely of steel, combines great solidity with extreme lightness. It is hung on very elastic springs. It is adapted to any form of body, coupé, landau, victoria, cab, &c.

The wheels are ordinarily furnished with Michelin pneumatics of 90mm., but are equally adapted for pneumatics of 120mm., or solid tyres.

The batteries used chiefly are those manufactured by the Fulmen Company in France. A battery of forty-four cells, with a capacity of 180 ampere-hours, such as is used on many of the Kriéger vehicles, weighs complete, with ebonite cases and the electrolyte, about 13cwt., and this size of battery will give a run of about fifty miles on level roads, under average conditions, a very satisfactory result. Our illustrations show two of the three forms of vehicles chiefly supplied by the syndicate, *viz.*, a very elegant and graceful victoria and a very substantial double landaulet closed. These can be used open or closed at will.

The King of Italy, we are informed, uses one of the Kriéger cars, as shown in our illustration. They have been largely introduced during the last two seasons, and we understand that a great number are on order for sale or hire. We would advise all those who are interested in electric automobiles to pay a visit to the establishment in Gillingham Street.

New Catalogues.

Electric Lighting Accessories. — J. H. TUCKER AND COMPANY, Sampson Road North, Birmingham. In the field of electric lighting accessories British manufacturers have made a reputation for themselves. With a superior article well designed and suitably finished they can face any amount of foreign competition. This may be rightly said of the Electric Lighting Accessories which form the subject of Messrs. J. H. Tucker and Co.'s new catalogue. High voltage tumbler switches are a particular speciality and are manufactured in every variety of type. Some neat patterns of supply switches for consumers' premises are also manufactured. These should meet a distinct want for the cheap double pole main switch.

Wires and Cables.—THE GENERAL ELECTRIC CO., LTD., Queen Victoria Street, E.C. The twelfth edition of the G.E.C. Wires and Cables Catalogue comes to us in wondrous guise. The Publication Department, which desires to produce something novel in the way of covers, have hit upon green sacking for the adornment of this particular issue. At first sight it looks as if penance was to be done and sackcloth worn for some offence not stated in the pages enclosed by this "bit o' bagging." But one is not easily scared by a cover. Indeed, its ugliness or otherwise excites curiosity, so that the result is the same in any case. Obviously one must get beyond the cover of any catalogue. The contents of the present production give full particulars and prices of Omega wires and cables, telephone cables and wires, insulators for every conceivable purpose, conduits, insulating material and wiremen's supplies.

Trucks.—MOUNTAIN AND GIBSON, LTD., Elton Fold Works, Bury. A comprehensive pamphlet describing the works and specialities of this firm is just to hand. Numerous illustrations are given of the shops and also of their chief products. Several designs of tramway and railway trucks are standardised and in addition specialities are made of trolleys, lifeguards and brakes.

Lightning Arresters. — THE BRITISH THOMSON-HOUSTON CO, LTD. Pamphlet No. 182 describes types G.E. and N.D.2 lightning arresters. The former are built for pressures from 1,000 to 12,500 volts, and the latter are made for continuous-current service.

Portable Railways.—LEWIS AND LEWIS, LTD, Townmead Engineering Works, Fulham. An illustrated pamphlet describes this firm's specialities in the way of portable railways, tip wagons, electric hoists, and saw benches. From the same firm we have also received catalogue sections 1, 2, and 3 bound together in a neat cover. A portion of it deals with the use of electric power for operating wood-working and stone-sawing machinery.

Boiler Evaporative Trials.—ED. BENNIS AND CO., LTD., Bolton. In the publication of technical literature relating to the value of their stokers, Messrs. Ed. Bennis and Co. are nothing if not emphatic. At the recent Tramways Exhibition we were handed a striking specimen of the kind in which facts and figures culled from the exacting regions of practice are concisely arrayed. In singing the praises of the mechanical stoker, engineers should be given figures not words or promises. They will find all of the former, but very little of the latter in Bennis's red booklet on Boiler Evaporative Trials.

The Old Order Changeth.

The *Norfolk Chronicle* says:

"THE ELECTRICAL MAGAZINE deals with applied electricity in every department. It is by a perusal of such publications as this that the ordinary person gets an idea of the extent to which electricity enters into the economy of every civilised community and its possibilities in the future. Verily, the old order changeth. Our forefathers thought so, aye, thought the world was coming to an end, when steam power first came into vogue. Electricity has eclipsed all that, and the only question is as to the limits of its application. In the matter of power, the latest issue of THE ELECTRICAL MAGAZINE illustrates what is literally a world of wonders. To the electrical engineer it must be invaluable."

The *Glasgow Weekly Mail* says:

"THE ELECTRICAL MAGAZINE this month is a bulky number, conserving the essence of the world's electrical thought and work, and having much that is of interest on cognate subjects. This month sees the commencement of a new volume, and in every way it is a big advance on previous numbers, having a specially attractive Traction Supplement. The special supplement gives complete reports of the proceedings of the tenth annual convention of the Incorporated Municipal Electrical Association, whose members visited this year Edinburgh, Glasgow, and Aberdeen, combining business with pleasure; the fourth annual conference of the Municipal Tramways Association; and full notes on the Electric Tramways and Railways Exhibition. The magazine can be thoroughly recommended to all interested in electrical and allied matters, and not least to the student."

The ELECTRICAL MAGAZINE is in the forefront of technical electrical journals.

The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. IV. No. 3. (21st Issue.) LONDON. SEPTEMBER 25, 1905.

The World's Electric Progress.

Peace.

OUR readers will, we are sure, join us in our expressions of relief on the conclusion of peace between the Far Eastern belligerents. War is always a distasteful expedient, to say the least of it, and the campaigns just brought to a close have illustrated this in no uncertain manner. With the motives of the contending parties we have, as a technical journal, nothing to do, but it is pleasing to us to remember that the success of the Japanese has been largely contributed to by the agency of electricity. They have been complimented on their Intelligence Department, but however complete its organisation or precise its details, these are unavailing without some speedy and ready means of communication. We feel convinced that when the real facts of the Russo-Japanese War come to light the success of the victors will be largely attributed to the judicious employment of modern methods of communication on the battlefield. The American Civil War first emphasised the value of the field telegraph, and by its aid many a turning movement, forced march, assault, and retreat was rendered possible, and generals came to regard it as a vital part of the fighting machine. Strict censorship over the events of the recent struggle has, despite all precautions, permitted to leak through news of telegraphs and telephones among the Japanese forces. It is generally accepted that the telephone formed an indispensible item of the scouting arm and aided in the discomfiture of Kuropatkin's hosts. On sea also the defeat of Makharoff was due to the timely apprisal by wireless telegraph of Admiral Togo's lurking squadron. That searchlights and the humble incandescent lamp have figured in the camps of both armies is quite conceivable; and when the historian can assemble the scattered threads of evidence regarding the uses of electricity throughout the war we anticipate their strongest eulogies of its influence in modern military and naval affairs.

The Coming Exhibition.

IN our last issue we announced our intention of publishing a great Exhibition issue in October, and urged upon manufacturers especially, the importance of the number from a business point of view. We emphasise this as our record of the Exhibition will be complete in every respect and eclipse anything yet done in the way of Exhibition Souvenirs. The secret of this Journal's success lies in the thorough and original manner in which it has during the twenty-one months of its existence comprehensively represented every branch of the electrical industry. As a review and digest of electrical work the world over it stands alone. Some few months ago it inaugurated a series of Special Supplements. The manner in which this was done appealed at once to the business instincts of those engaged in running the commercial side of electrical concerns. Many representative firms have during the past several months availed themselves of these special opportunities presented to them for exceptional publicity. They have benefited accordingly, and will benefit still more as the

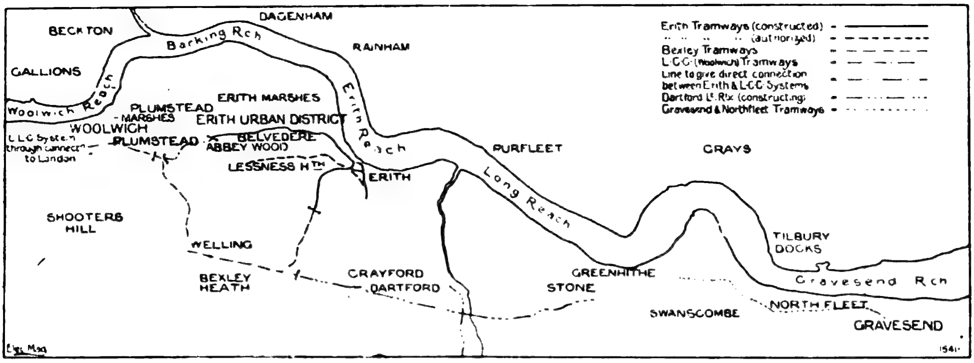
records of their work filter through the right channels during the coming time. Much as this Journal has done to further the interests of British electrical manufacturers, an effort is now about to be made, sure—from every indication, of fruitful accomplishment—to crown the work hitherto successfully attained. We can say without hesitation that no electrical paper has produced, or *will* produce, an issue which in interest or commercial utility will equal the Souvenir Number which we shall publish in October in connection with the Olympia Electrical Exhibition. It will be unique in every respect and the extensive arrangements we have made for its contents and widespread circulation guarantee absolutely maximum value at minimum cost to all those who avail themselves of the opportunity of being represented therein. We are providing that the Magazine has in October at least *twenty thousand* readers. No further comment is necessary. We simply advise all those firms who have not already booked a representation in this great issue to communicate with our offices without delay, as, notwithstanding the fact that the number will be greatly enlarged, we have already such a demand on our space that it will shortly be all absorbed, and in view of the heavy expense involved, we shall be unable to make any further increase in the pages. Those who remain out will regret it when they see the issue. Exhibitors co-operating with us will secure world-wide publicity in regard to their exhibits. Those who are not exhibiting will be able, through THE ELECTRICAL MAGAZINE, to keep themselves in strong evidence. To electrical manufacturers, one and all, the forthcoming great Exhibition Issue of THE ELECTRICAL MAGAZINE strongly appeals.

Tunnel Developments Around New York.

NEW YORK cannot claim distinction as being a city set on a hill, but it is certainly unique in that the greater part of it is built on an island. A continued expansion of greater New York, and the growing importance of the city as a commercial centre, has brought up problems in transport which are probably without parallel at the present time. It can with truth be said to be overrun with electric trains, seeing that the bulk of its transport is accomplished on elevated tracks. Shallow subways are also becoming popular, and as completed will take up their share of the task of public transportation. This, of course, relates to the traffic facilities on and about Manhattan; but even greater things are being done in getting heavy long distance trains into the heart of the city. In our Transport Section this month we publish a map which illustrates the tunnel projects beneath the Hudson and East Rivers, all of which will become important avenues of railway traffic. These tunnel schemes, though very costly, are preferable to bridge building, while they are infinitely safer and admit of higher average speeds. No less than eight of these tunnels are in course of construction, and it is expected that in from two to three years' time the whole of the work will have been completed. Electric trains will in each case traverse the tubes, the steam coaches being picked up by electric locomotives on the far side of the river in each case. The tunnels under the North River being driven by the Pennsylvania Railroad Company connect with a terminal station in New York and pass from this point under the East River to Long Island. The engineering problems constantly presented are being successfully met, and although rock is being encountered the work goes steadily forward.

Erith Electric Tramways.

WHAT will soon prove an important connecting link in the electric tramways of Greater London has recently been opened in the shape of the tramways system of the Erith Urban District Council. Erith claims whatever honour there may be in first adopting three phase generation and distribution for lighting purposes among English towns, and has been the proud possessor of its system since the beginning of 1903. Its progressive spirit has not, however, remained satisfied until electric tramways were operated from the same station. After parleying with the London County Council and obtaining practically no satisfaction, the Council procured Parliamentary powers for the construction of its own lines. Through the courtesy of the consulting engineers, Messrs. Hawtayne and Zeden, we were able to attend the official opening of the system, and from what we saw must compliment them and their clients on the successful outcome of their efforts. The accompanying map will give some idea of the ultimate importance of the system when connected up with neighbouring routes. A junction with the Bexley Heath trams has already been effected, and it is



MAP SHOWING THE NEW ERITH ELECTRIC TRAMWAYS AND CONNECTIONS.

hoped that the southern L.C.C. lines will shortly be available to Erith passengers. The electrical features of the system call for no special comment, high tension three phase current being generated and distributed to rotary converter substations. The line passes through pretty country districts, and in some cases along narrow roads which only admit of a single track. At Abbey Wood the railway is crossed, but the level crossing has been done away with and a substantial bridge erected to carry the track over the metals. Some of the gradients are as steep as one in twenty, but the cars are fitted with electro-magnetic track brakes and consequently may be regarded as perfectly safe.

Our Gas Power Supplement.

WE are pleased to present our readers this month with descriptions of representative apparatus relating to the manufacture and utilisation of power gas. As we point out elsewhere, the large gas engine—and with this must be included the large oil engine—is now in a strong position to compete with steam prime movers of equal output. The development of the gas engine is a matter of the utmost importance to the power-using industries of this country. The possibilities which it presents of converting the latent energies of coal into useful work by a more direct path than is now taken with the steam engine are now fully recognised, and it seems to us that by co-operation and united organisation gas engine builders can within a short period obtain the cream of the engine business now done in the electrical field. It is in the building of monster units that their hope of success lies, in the same way that the large steam turbine is efficiently competing with the clumsy reciprocating engine. It seems to us, however, that there are two dangers ahead in the coming gas engine boom. The first of these is the need for returning to the very heavy types of dynamo machines necessitated by the slow speeds common to gas engine practice. The second lies in the possibilities of small suction plants as strong competitors of the electro-motor. In many towns central station engineers have a hard fight to replace gas engines by motors, and in outlying districts, where service gas is not available but where cables may be laid, the difficulties of ousting the gas engine are increased. Of course, the gas engine as a power agent is in no way improved mechanically for being run from a suction producer, so that the arguments of the electrical engineer on the grounds of its complicated construction compared with the simpler motor are not diminished in the least. When we have a few power companies operating from gas driven stations the case for the suction plant will not be so rosy, as the electrical engineer will be able to offer more enticing rates. Until then, however, the suction gas plant, despite its drawbacks, is likely to prove a powerful rival to the electro-motor, and if beaten at all it will be in exceptional cases favouring the peculiar advantages of motor driving.

A Captain of Industry.

PROBABLY no one man in electrical circles comes under the searchlight of the lay Press, at any rate, than does Mr. George Westinghouse. Such tributes as are given to the world of his undoubted genius

as an inventor and organiser, are frequently prosy, and lack vitality. The "American Illustrated Magazine," however, errs on the right side in publishing the opinions of Robert Mayhew, who depicts "the great George" in pleasing colours. He says: "At fifty-nine George Westinghouse stands as the originator, organiser, and responsible directing head of industries employing 30,000 persons, on whom 75,000 more are directly dependent, and indirectly supporting 25,000 persons in addition to these. None but the German manufacturer Krupp comes to mind as equalling Westinghouse in industrial importance. Where Krupp built with destruction in view, the genius of Westinghouse ever has been directed to improving and enlarging the arts of peace. The financier whose manipulations in the field of speculation give a false value to securities of doubtful merit, who, when he has boosted prices to an attractive figure, steps from under after pocketing the profit of the faith of the public, may be of some use as a patron of the arts and gentlemanly sports, as the supporter of great private estates, as a generous tipster of menial servants, and in other ways in which money may be prodigally kept in circulation; but does he compare in usefulness with the great nurseryman who conceived and fostered and to-day guides and controls the parent plant and the spreading branches of the Westinghouse works? George Westinghouse is a great big man physically and mentally. His is a giant's body, but his mind outclasses it. He is shrewd, far-sighted, goes straight to the heart of any problem, grasps every point of a subject quickly, separates the practical from the chimerical immediately, and enters enthusiastically into anything that appeals to him as of merit. Once convinced himself, he has no difficulty in convincing others. He is bland and smooth, reasonable within human bounds, but impatient of opposition. That which he enters into he dominates, not through the mean spirit of pride of power, but from the consciousness of inherent superiority, a self-confidence justified by his own accomplishments in a long career of conspicuous success."

Electrons and Politics.

It was a happy and fitting comparison drawn by Professor G. H. Darwin, in his Presidential Address to the British Association at Cape Town, that the life of an atom is readily comprehensible from political analogies. At once this brings complex matters of physics within the mental grasp of the simplest, and sweeps away the barriers, which science has been unjustly accused of raising around her researches. Although the average layman would regard Professor Darwin's address to the British Association as beyond his depth, we can assure him that its delightfully elementary language would make for him most interesting reading. The pith of his deductions regarding the life of the formerly indivisible atom can be put into a few words: the existence of atomic forms is subject to the great law of evolution—the survival of the fittest. The atom with its thousands of corpuscles or electrons is constantly undergoing disintegration, and the process is subservient to the principle that only the fittest survive, the unfit being expelled or radiated from the tiny globe. Subsequently the remaining electrons assume a stable condition again, but the resultant atom possesses less energy than before. To quote Professor Darwin: "The time needed for a change of type in atoms and molecules may be measured by millionths of a second, while in the history of the stars continuous changes occupy millions of years. Notwithstanding this gigantic contrast in speed the process seems to be essentially the same." Physical and biological researches such as those involved by deductions of this kind are sometimes regarded as objectless and barren of result, but the very nature of the conclusions reached affords ample justification for the work. Are not the labours of individual scientists comparable to the electron revolving on its axis and contributing to the disintegration and subsequent reintegration of the atom, thereby performing some function of the universal scheme? It must be remembered that the very evolutionary laws which science propounds are applicable to the efforts of her votaries. The deductions of Professor Darwin, leading us into new avenues of thought on the functions of material forms, will ultimately prove valuable vehicles of expression regarding the causes and processes which go to make up those functions. From speculation to conclusion and thence to proof are but stages in the great process of research, and we must bear with patience the periods which necessarily must elapse before developments reach a practical stage.

THE WINDMILL.—VII.

Operated by DON QUIXOTE.

The Tantalising Telephone.

In the East End of London, where delightfully descriptive language luxuriates, the humble sausage is allusively termed a "bag o' myst'ry." Now history records that the birth of the telephone was as follows: A German philosopher (than whom who can be more aloof from the mundane limits of the commonplace?), whose name was Johann Philipp Reis, took the bung of a beer-barrel and the skin of a German sausage and, scorning the base uses to which these had been aforetime put, fashioned the former into a hollow cone, whose orifice was stopped, as with a tympanum, by the German sausage-skin.

Speaking in the mode of our vivacious confrères of *l'entente cordiale*, we have changed all that. The modern telephone is a highly polished, ornamental instrument which is worthy to be borne in the arms of a very pretty girl in an illustrated advertisement, as one of the "Three British Modes." And we never nowadays refer to the circumstances of its birth as being too much "wropt up in a mistry," as Charles James Yellowplush hath it. Yet unfortunately its initial characteristics still cling to it; the telephone is nothing but a "bag o' myst'ry."

Early in its childhood it migrated, for some unknown reason, to America, where it embroiled two otherwise sedate inventors, or their adherents, in a faction fight that was only ended by the Edison-Bell amalgamation. Still its unquiet soul remained unsatisfied, for to this day bitter war is being waged between that early combine and the group of later growth that calls itself Independent. Why, in a land of mammoth trusts, these interests have not before now been amalgamated is one of the many sphinx-riddles connected with the telephone.

In England this instrument is causing untold trouble. Quite apart from neurotic diseases of telephone girls and the blasphemous horrors of subscribers' language, the amount of froth and pother that is being raised between Municipal telephones, National telephones, and Post Office telephones is so inconceivable that the editor of one of our electrical journals commences: "Most people are utterly tired of the telephonic question, as indeed we are, but. . ." —proceeds to write a leader on it, one column and seven-eighths long.

And the mystery of it all is that nothing particular happens. For example, some time ago two eminent consultants, one a Municipal telephonist, one a Nationalist, got up and went for each other in the columns of a periodical in such manner as was never seen since the encounter of the editorial lights of Eatanswill, Messrs. Pott and Slurk. And yet, just as men were asking what the lawyers' fees would come to, the controversy fizzled out, and, save for an occasional explosion, the combatants are at peace.

Again, the town of Brighton, being an object-lesson in municipal telephony, has been alternately lauded to the skies and howled down to perdition. And yet Brighton frivols along as of yore. Judging from information received, I imagine that if Brighton does go to Heaven, some of its inhabitants will need, in the words of Hudibras, a "godly, thorough reformation." And, on the other hand, if Brighton is dropping into the abyss, it is only dropping there in detail.

And, finally, there is the great, insistent, repellent question of the transference of the National Telephone Company's interests to the State. In the beginning of things the Controllers of the Nation's Destinies rather imagined the telephone to be a good thing, but got scared at the idea of spending a few pounds in experiment, and generously allowed a private company to show some pluck. Virtue being rewarded, the company reaped a rich harvest, and created a monopoly. Government opened its eyes in sleepy amazement, and after certain wobblings allowed municipalities to put up telephones of their own. But the Government, in its slow, heavy, drowsy way, had by now decided that telephones were a nice fat morsel that must be absorbed by the aid of those secretive juices known as the Telegraphic Acts—with perfect justice, mark you, or of course the Government would not dream of it. I wonder if the cobra meditates on the justice of things as it engulfs the sucking pig? And so, after an agreement has been patched up between the State monopoly and the National monopoly, now grown rather fearful of municipal systems, a Parliamentary Committee deliberates as to the justice of that agreement, and whether it is binding or not. And after much trouble in Committee it is settled by a party vote in a half empty and wholly-bored house that the agreement shall stand and that no more municipal licences shall be granted.

THE OLYMPIA ELECTRICAL EXHIBITION.

Some Views of Electrical Manufacturers.

By the time this issue is in our readers' hands the first representative Electrical Exhibition held in this country will have opened its doors to the public. At the moment of going to press we have secured a few expressions of opinion from prominent electrical manufacturers exhibiting at Olympia, and these views, coming as they do from various quarters, will be found of considerable interest at the moment.

The few questions we sent out to heads of large firms (more as a guide to frame their opinions than as queries needing precise replies) met with a fair response, but extreme reticence doubtless dominates all official utterances; consequently the number of replies we can present to our readers is more limited than was anticipated.

The exhibition has every promise of being a complete success judging by the manufacturing support accorded it and by the character of the apparatus to be displayed on the various stands. It will of course not be mistaken for an exposition of electric progress, as its objects are to stimulate public interest in matters electrical and encourage the uses of electricity from public service mains. It is really the reply of the electrical industry to the Gas Exhibition of last year, and will emphasise the important status of electricity supply in a manner never before attempted in this country.

The Deputy Chairman of the Electrical Exhibition, Mr. C. S. Northcote, M.I.E.E., Managing Director of Verity's, Limited, has written us on the prospects of the Exhibition as follows:

"I think without doubt that the results will benefit the electrical trade more directly than any similar exhibition previously held, because the trade are controlling the Exhibition, and are thus able to present their manufactures to the public in their own way and, it is to be hoped, to their own benefit. The wholesale distribution of tickets by corporations and supply companies, who have supported the scheme, in addition to those distributed by the exhibitors themselves, will result, I believe, in the public taking an unusually keen interest in this the first Electrical Exhibition run by the electrical profession and trade itself.

"The adoption of electric power for small works and shops, of ventilating fans, heating and cooking apparatus, high efficiency and improved incandescent lamps, &c., is the direction in which the supply engineer, in my opinion, has to look for increased output. A varied and up-to-date display of apparatus, manufactured and supplied by English companies and firms, will be assembled together in such a manner that the visitor and possible user will have an opportunity of making comparisons, and realising what they are, and this should improve the electrical trade in this country for some time to come, in creating a demand for such apparatus, which in turn, it may naturally follow, will increase the output or load of the station system to which it is ultimately attached.

"I decided to devote a considerable amount of time and attention to the affairs of the Exhibition, because it was felt by myself, as a director of a large electrical manufacturing company, in common with many other of my friends and colleagues in the business, that the numerous and comparatively unimportant exhibitions held from time to time for a day or so in various parts of the country and London put a firm or company showing their goods to a disproportionate amount of trouble and expense with little or no possibility of direct result, owing to the shortness of time in which their goods were on show, and the incompleteness of the exhibition generally. The bulk, if not the whole of the present important exhibitors at Olympia are, I have gathered, generally of the same opinion, and it is fully anticipated that before the close of the Exhibition an understanding throughout the electrical trade will be arrived at, whereby a fully representative and complete exhibition, larger possibly even than the forthcoming one, will be held under similar patronage and auspices in a year or two's time.

"The improvement in the tone of a business where a number of firms are working with one common object, as in the case of this Exhibition, for a boom in the trade and a successful show, is bound to have lasting effect on the general morale of such business or trade. That a better understanding between manufacturers, one towards another, and electrical contractors—their customers—

has been wanted for some time is, I think, clearly shown by the useful work and comparative success of the National Electrical Manufacturers' Association and the Electrical Contractors' Association. They have been brought closer to each other, both as fellow-members and as fellow-traders, and, speaking personally and on behalf of my company, I would say at once that the tone of business in the trade, particularly during the past two or three years, has improved in a marked degree, owing primarily to the existence of the above-named Associations. The Exhibition will strengthen them, and develop their work doubtless, and this should contribute materially towards maintaining the success of the British electrical manufacturer, who is, in my opinion, quite capable of holding his own against the world, if he receives that support due to the energy and capability which he or his colleagues may have displayed in building up an extensive, successful, and, it is to be hoped, a deservedly profitable business."

Mr. J. R. Dick, B.Sc., M.I.E.E., Managing Director of W. Lucy & Co., Ltd., electrical engineers, Oxford, regards the Exhibition with commendable optimism, as the following opinions show:

"To the general public the Exhibition will serve as a mirror of the present state of electrical manufacturing. Many of them will be attracted by a sense of the marvellous, while most of the exhibitors are actuated by a sense of the commercial. The more of the Geissler tube and high-tension arc elements there are the better the public will like it. The individual exhibitors hope it will direct attention to their specialities and advertise their novelties, but it is doubtful how far the exhibition will influence the *fons et origo* of all electrical enterprises—the consumer. If he could only be obtained 'in bulk' with facility the chief commercial difficulty of electricity supply would vanish, for there is plenty of ability in the profession to cope with engineering questions.

"For the London undertakings the result will no doubt be an accession of business, but in provincial towns the labours of the engineer to develop his own particular field will scarcely be mitigated. A placid growth of the lighting business is the usual characteristic of central stations, and to enliven it resort must be had to hard personal work and to the employment of all the devices current in business circles when expansion is desired. To fix a suitable tariff, to reduce prices, to be frankly commercial, is the way to succeed. It is better to have a large turnover and a good balance-sheet than to have a reputation for minor engineering economies. To secure this desirable result a local electrical exhibition is often of service, but systematic canvassing, circularising, and advertising should play important parts in the programme. Under modern conditions, however, it is the question of power supply that is of the greatest importance to supplier and would-be consumer. The temptation to use suction gas engines for motive power, with their low cost per unit, is difficult to withstand, in comparison with the electrical engineer's usual offer. Fortunately the power distribution companies and undertakers generally, by intelligent anticipation of what their costs will be in the future, are basing their price to-day on these figures, and are making successful headway against all competitors, especially where load factors rule high. In cases with poor load factor, where the factory owner's requirements permit the cessation of work during peak hours, a very low price may be offered.

"It is to the galvanisation of industrial England by power companies that manufacturers who are their immediate parasites must largely look for their future prosperity.

"Any exhibition that affords opportunities of seeing the applications of electricity or of popularising electrical inventions will hasten the day when electric power in a manufacturing area will be as simply and conveniently obtained as a supply of water.

"To manufacturers themselves the exhibits are means whereby their position in the trade can be determined, and whatever business may directly result will probably be quite as much with their electrical brethren as the general public. From the friendly criticism of each others' stalls, improvements in design will result by holding fast that which is good and rejecting that which is otherwise."

Mr. F. B. G. Hawes, A.M.I.C.E., A.I.E.E., Director and General Manager of Langdon-Davies Motor Co., Ltd., writes:

"We trust that the Exhibition will do some good in educating the public to the uses of electricity, regarding which we still find a very great amount of ignorance. Cheapness of and simplicity in the methods of charging for electric supply will, I think, be the most popular development. I doubt whether there is any alteration in public

interest in electric progress as affecting their near interests. This is a matter, however, of which I have not much opportunity of gauging.

"Tradesmen and power users in the provinces will, I fear, be more attracted towards the use of electricity by exhibitions in their own town than by a large one in London. The London one, however, it is to be hoped, will increase the use of electricity in London.

"It appears to me impossible to specify any special stimulus which would ensure a greater stability for the electrical industry, but there would appear to be one point which would undoubtedly assist: a cessation of the present class of legislation, which is so seriously tending to discourage private enterprise.

"British makers of electrical apparatus are certainly not holding their own against foreign competitors in most cases, and without some form of protection there is no reason why they should, as cheaper labour and equal natural facilities are to be found in other countries, which have us for their market, but in which we cannot sell."

MR. H. J. DOWSING, M.I.E.E., Managing Director of the Dowsing Radiant Heat Co., sends us a few ideas which we reproduce as follows:

"I am of the opinion that the time is ripe for a fully representative Electrical Exhibition. During the last few years immense strides have been made in the applications of electricity, with which only those connected with the business are fully acquainted. It is necessary that the general public should be made aware of these facts, and the proposed Exhibition should be of great value in this direction. I am well acquainted with the value of such exhibitions as this, having been one of the organisers of the last Electrical Exhibition, held at the Crystal Palace in 1892, from which date commenced the enormous extension of the electrical supply throughout the country. At that date few supply stations were at work, and now there are over 382. Electric traction then was little known, now we hear of it everywhere. Electric lighting has been greatly improved and cheapened, and various uses have been found for electricity, which at that date were little dreamed of.

"Domestic uses of electricity have vastly extended, and the demand for electricity for electric heating and other similar purposes has greatly increased, and I believe there is a very great future for it in this direction. I think the public interest in electricity has also largely increased, and owing to the growth of new electric tramways, railways, and other systems of locomotion, people are prepared to see much greater progress, and with the knowledge will come the appreciation.

"One of the best means of increasing the interest of tradesmen and others in the use of power and lighting by electricity is to simplify the charges, for I believe many do not understand the system of charging, and often regard it with suspicion. A low rate of charge for power and heating is, of course, essential to compete with other systems. The Exhibition at Olympia will be the means of introducing the use of electricity in many other ways, and an interesting development will be on show, *i.e.*, an electric light disinfector in which electric heating combined with the bactericidal qualities of light are employed for the first time in this way.

We have had the pleasure of an interview with Mr. Gustav Byng, Chairman of the General Electric Co., and have also received a special article on Olympia Electrified, from the pen of Mr. L. M. Waterhouse. These are placed separately on account of their length.

The Olympia Exhibition and the Electrical Industry.

By GUSTAV BYNG.

GUSTAV BYNG.

UNDER existing circumstances I scarcely see my way to favour exhibitions in Great Britain at all. Competition is already very keen, and where an English firm takes a stand at a foreign exhibition it is prescribed that under no circumstances should that firm affect a title which is calculated to allow buyers to think that the firm belongs to any nationality other than England. Whereas over in this country we allow firms from all parts of the world to exhibit their goods and at the same

time to assume a title of an English character, which is so misleading to the public in general that they are forced to think they are buying British made goods, in addition to which, when the foreign firms obtain orders in consequence of exhibiting here, those orders are executed abroad, and the goods are allowed to enter into this country free of duty, whereas if an English firm exhibiting on the Continent obtains orders it has to pay a duty on sending those goods to their destination. However, so far as the Olympia Electrical Exhibition is concerned, I know that it is supported by such influential firms that I must necessarily be represented, in addition to which I am not displeased in doing so.

It would scarcely be right to say that the public interest has in any way declined as regards electrical progress, but electricity is no longer the novelty which it was some years ago, and the public nowadays look upon it more as a matter of course. Indications, however, prove that electrical matters appeal more to the general public to-day than ever before; it may be expected that this interest will considerably increase and not decrease.

The most important development which should be conducive to popularising electricity supply would be to cheapen the price. There is not the slightest doubt but what an exhibition in itself has a tendency to popularise electricity, but where the public is concerned, price is a consideration; and we ourselves have during several years past been able by means of continued improvements to cheapen to the public the price of electricity.

In my opinion central stations should undoubtedly use every means in their power to advertise the fact that they exist. It would improve electrical trading generally and open up a wide field by which electric motor cars would be much more universally used than they are at present. The charging is one of the difficulties which the owner of an electric car has to contend with, and if the central stations only exerted themselves by means of advertising, a great deal of this difficulty would undoubtedly be overcome.

British makers of electrical apparatus are not holding their own against foreign competitors, the reason for which has been referred to above. Our fiscal policy as it stands at the present moment makes it impossible for us to compete in a favourable way with foreign firms. It is unnecessary for me to go into the question of the tariff wars which are raised against us on the Continent; such must necessarily appeal to all reasonable thinking people. I can only say this from a practical point of view, and speaking from years of experience. If we can only place an equal tariff upon goods entering this country as foreigners impose upon us when our goods enter their countries England will not only be able to uphold its position in the electrical world, but we shall be able to employ between five and ten thousand additional hands, the manufacturer will advantage, and the public in general will advantage, and I strongly assert that the result would impose no increase in price upon anything electrical. Failing such a change in our fiscal policy at a not far distant date it will be impossible for England to retain a fair position in the electrical markets of the world.

Olympia Electrified.

By L. M. WATERHOUSE,
A.M. Inst. C.E., M. Inst. E.E.

L. M. WATERHOUSE, A.M. INST. C.E., M. INST. E.E.

THE half-century which has elapsed since the germination of the exhibition idea has served to demonstrate how firm a hold this method of stimulating trade has taken on the British public. During this period exhibitions have been promoted on a very large scale in this country and on the Continent; even Japan in her wholesale adoption of European ideas has held her exhibition at Tokio, and America, always to the front, has made her usual attempt to lick creation in the size and magnificence of her World's Fairs.

Electricity, though still relegated by the non-technical Press to its infancy, from which stage presumably it will never be permitted to emerge, has nevertheless developed so rapidly, in its application to light and traction, and in numerous other directions, both commercial and scientific, that one

cannot but regret that more use has not been made of electrical exhibitions to familiarise the public with the enormous potentialities of this increasingly important factor in our daily life, and to bring home to them some idea of its limitless possibilities for the future.

Electrical sections have formed a conspicuous part of all large international exhibitions, and have contributed in no small degree to their success; but exhibitions solely devoted to electricity and its commercial application have not hitherto been organised in this country on lines which have proved altogether satisfactory. Expensive bands, concerts, and other attractions, which have been inseparable from exhibition work of late years, have attracted a public whose interest was centred in amusements, and attention has thus been diverted from the trade section of manufacturers' exhibits, which in many cases have served but as excuse for the name. The heavy expenditure involved in entertainments of this description has led to the financial failure of many an exhibition which might otherwise have been a success on its own merits.

The Electrical Manufacturers' Association are to be commended for their initiative in endeavouring to remedy the existing state of affairs by promoting the first Olympia Electrical Trade Exhibition, which has been organised under the most favourable auspices. Olympia possesses many advantages as an Exhibition building, it is both central and accessible in comparison with other available halls, and offers sufficient accomodation to meet present requirements, and the date of opening is well calculated to meet the joint convenience of the public and the trade. The Exhibition remains open for a sufficient period to warrant the manufacturer in going to a substantial outlay in the production of an exhibit that will do credit alike to the Exhibition and to himself. The active support of the technical Press, always so readily accorded, will most assuredly be forthcoming, and this is a factor the importance of which it is hard to over-estimate in forecasting the success of an exhibition.

Viewed from the advertising standpoint, there is possibly no other way, given satisfactory conditions and organisation, in which money may be spent to greater advantage in obtaining publicity for one's goods, and this was strikingly shown at the Motor Exhibition held at Olympia in the fall of last year.

A novel or interesting speciality is no doubt always calculated to command attention, but a point of paramount importance, and one too often overlooked, is the personality, education, and qualifications of the firm's representative left in charge. To instance the lamentable ignorance of some attendants, the following came under the writer's observation:—A gentleman, after vainly endeavouring to obtain some particulars of an engine, asked if he could be supplied with an indicator diagram, and received the reply, "Our firm does not make them, but they can be obtained at a stand where they deal in accessories!" Another enquiry as to the flexibility of a petrol engine produced the sarcastic retort, "The engine is made of cast iron, and therefore cannot be flexible"!!!

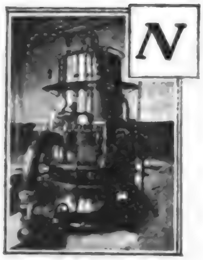
Capable representatives contribute largely to the success of an exhibition, and it is a mistaken idea for a manufacturer to suppose that he has completed his part after producing a perfectly arranged exhibit. What is wanted is that somewhat *rara avis*, a representative or traveller who has been through the shops, and can talk intelligently as to construction and details.

The advisability of granting awards to successful competitors is a question about which a great divergency of opinion exists. Of late years any advantage accruing to holders of medal awards has been largely discounted by the wholesale and reckless manner in which "medal certificates" have been distributed to all and sundry. There does not appear to be any valid reason, provided judging is carried out by qualified, representative, and impartial experts, why the awards of recognised exhibitions should not carry weight with the public, and at the same time act as an extra inducement to the manufacturer to put forward his best efforts in his own interests, and so contribute in a larger degree to the success of an Exhibition.

There is, fortunately, but little doubt that Olympia electrified will be a successful exhibition, and of great advantage in educating the public, in addition to stimulating the electrical trade. It is to be hoped that the results will not only repay the promoters for the initiative and industry which have brought this Exhibition into being, but will also encourage them to institute an Annual Exhibition on similar lines, as an aid to the more rapid progress of electricity supply.

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Electric Power for Naval Auxiliary Machinery.



NAVAL authorities maintain an astounding indifference to the progress of invention and are as slow at manœuvring in the sea of industry as are their great ironclads on the ocean. Within only quite recent years has our own Admiralty bestirred itself in the matter of electric power for quite the insignificant operations requiring mechanical aid on board a battleship. It is consequently not astonishing to find that our tardy officialdom has been outstripped by so breezily progressive a navy as that of the United States. Mr. L. C. Brooks, writing to the *American Electrician*, says that five years ago the *Kearsage* and *Kentucky* were far in advance of their time in the matter of electric driving of auxiliary machinery. These vessels, each of 11,600 tons displacement, had a generator equipment of 350kw., and were fitted with Ward Leonard controlled motors turning turrets of 710 tons. These contained two 12in. and two 8in. guns. The same ships had thirteen fan motors absorbing some 90kw., and all boat cranes, deck winches, ammunition, &c., were electrically operated. Mr. Brooks in a lengthy article then proceeds to describe the present practice for vessels now going through.

Two separate generator rooms are used, complete with independent steam accessories, and breakdown is provided against by interconnecting feeders. Distribution boards are in separate watertight compartments, and feeders are run in enamelled iron conduits, except in unexposed places, where insulator hangers are used. Special specifications for the plant are prepared and must be strictly conformed to. Motors, for instance, above 4h.p. must be multipolar, have separate field windings if compound, have no less than

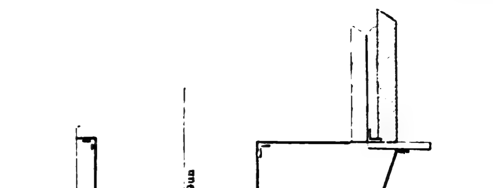


FIG. 1. ELEVATION OF ELECTRIC TURRET TURNING GEAR.

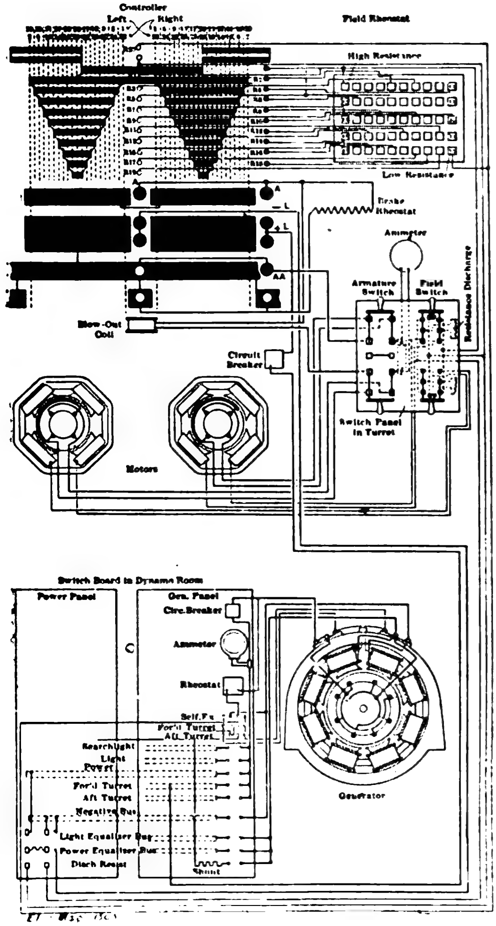


Fig. 2. Connection Diagram, Turret Motors.

9 per cent. speed variation below 5h.p. and 6 per cent. above that output, have ironclad armatures and protected fields and carbon brushes. Controllers, to take another instance, must be absolutely watertight and capable of operation by one hand, while all fittings must be in non-corrosive metal. Rheostats are important accessories and great care is needed in their design and manufacture. At full load current they must not exceed 100° C. above surrounding air at any part, and the resistance material must not suffer damage at 150° C. or by salt water action. They must also be insulated from the ship.

The article then proceeds to describe and illustrate certain auxiliary devices commonly operated by electro-motors. Fig. 1 depicts the turret turning gear in which two enclosed shunt motors operate through spur gearing on to a mitre shaft. The same shaft carries a worm driving a vertical shaft through a friction clutch. The upper end of this shaft carries a pinion engaging in the turret rack. The clutch propels the gearing and also takes up jars through suddenly stopping the turret from impact and from the effect of being struck by a shot.

The speed requirements are very severe, ranging from a rate of one revolution of the turret per hour to one per minute. To accomplish this the Ward Leonard system is used and the motors are put in series. Speed control depends on armature speed running in a constant field, being proportioned to the volts impressed on the brushes. A generator is therefore needed for each turret, though a special motor generator is sometimes used. Fig. 2 is a diagram of the connections when one of the regular generators is employed. The generator field regulator is replaced by a special rheostat in the turret operated by the controller. The compound winding is shunted by a resistance to enable prompt starting to be made. The motor fields are separately excited from the power lines. With the turret controller off the motor brushes are connected through a low resistance, so that a powerful brake is provided to stop the turret. With the motors in series at full current a powerful starting torque is given with fine speed adjustments. The controller has twenty-five positions, the first twenty giving full field at about half the maximum speed. The last five notches bring up the motors to full speed. One motor alone is capable of operating the turret should the other fail from any cause.

For ventilation shunt motors are fitted, and in addition to delivering the specified volume of air at 1oz. pressure are required to

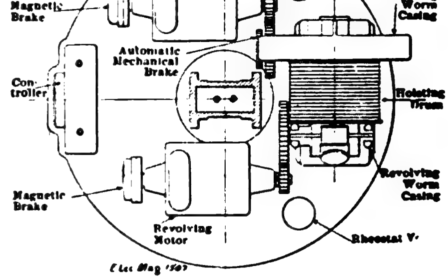


Fig. 3. Plan of Electric Boat Crane.

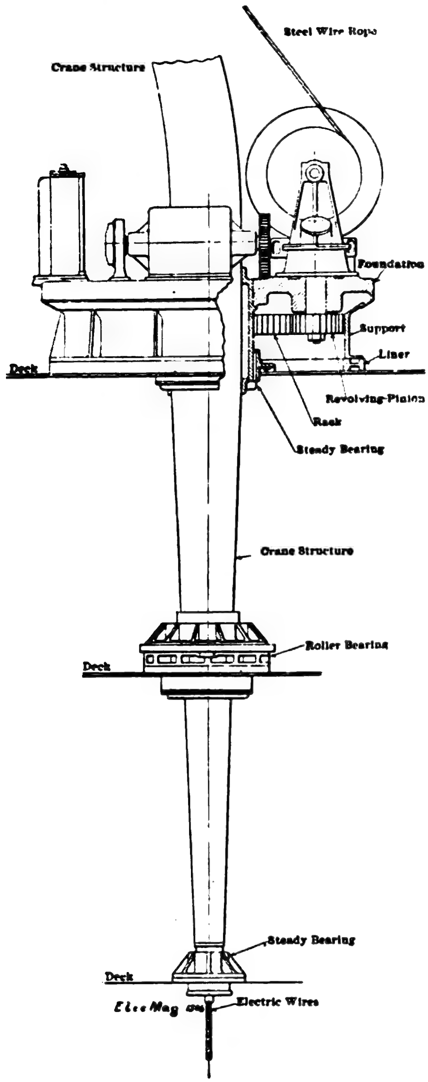


Fig. 4. Elevation of Electric Boat Crane.

increase this to 1½oz. at higher speeds. A four days' run of the fans in position has to be passed satisfactorily before acceptance.

Figs. 3 and 4 illustrate a type of boat crane which has given very good results on steady bearings at the weather and second decks, and all parts are designed for a maximum fibre strain of 7,500lb. per square inch. Two series wound enclosed motors furnish the requisite power, one for hoisting and the other for rotating the crane. The winding drum is driven through worm gearing from the spur wheels with which the motor engages. The slewing motor drives, by way of spur and worm gearing, on to a pinion meshing with a rack. Each motor shaft is fitted with magnetic brakes capable of holding the full load of the crane. The rheostats are housed below the foundation plate, and are accessible through inspection doors. A special automatic mechanical brake is provided which controls the load when lowering and prevents the attainment of excessive speeds. The controller is arranged to place the armature in parallel with part of or all the resistance except at full speed. This method of connection enables the load to be moved through small distances, as the speed increase can be gradually made.

The turret hoists are specially arranged for both hoisting and lowering. The former is done with a simple rheostatic motor control, but with the latter a different method is employed. The rheostat is thrown directly across the line and at the intermediate positions is gradually parallel with the armature which is short circuited at the "off" position until at full speed the rheostat is in parallel with the armature. With this arrangement the motor takes current when

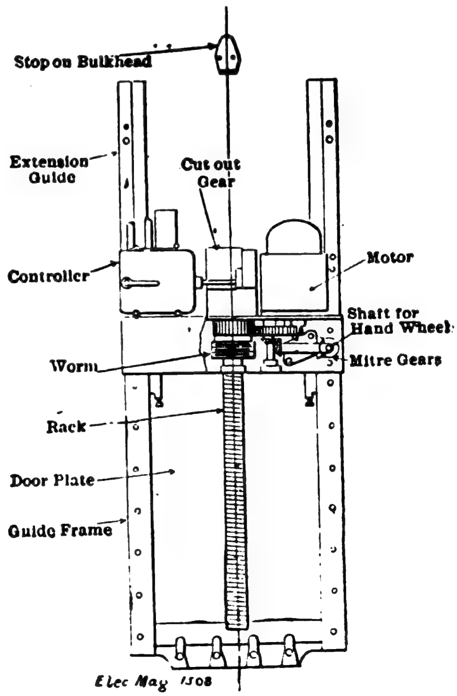


Fig. 5. Electrically operated Bulkhead Door.

lowering light loads, but with heavier loads it acts as generator and sends current through the resistance. The total weight of ammunition and car is 2,970lb. for 12in. hoists and 950lb. for 8in. hoists.

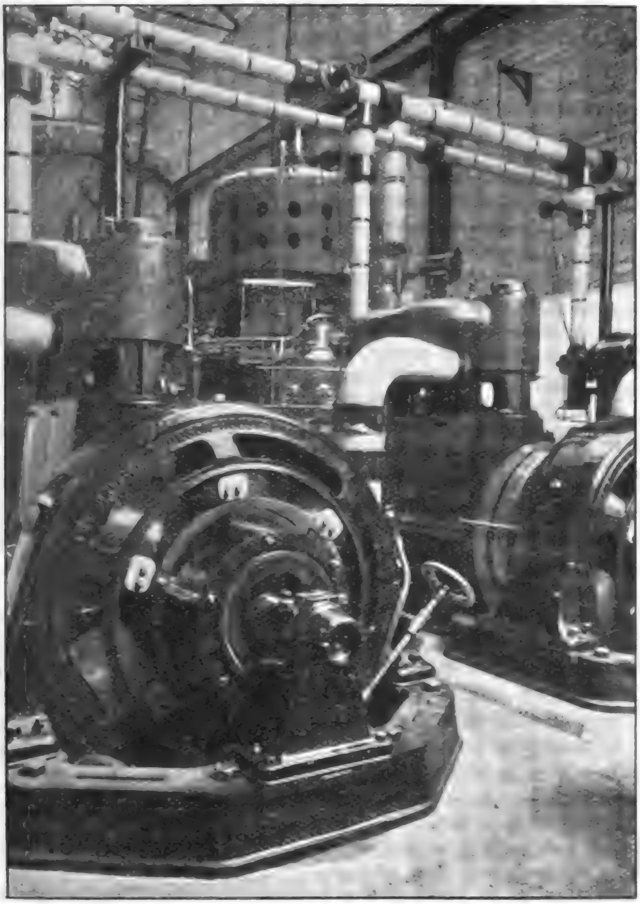
An interesting motor application is noticeable in the power doors, one of which is depicted in Fig. 5. These are employed for the most important hatches in the protective deck and the doors through the principal water-tight bulkheads below it. An enclosed compound-wound motor drives through two pairs of spur gears a worm engaging a rack on the door, so that the movement is quite positive in either direction. A controller without resistance, but having a limit switch, actuates the motor, and by releasing the handle the door will stop in any desired position. An emergency system of control is also fitted whereby the doors can be closed from a distance. In this case the controller is started by a solenoid energised by the emergency switch. An indicator board shows the commander of the ship the exact position of the doors. Numerous other devices are actuated by motors on board the vessels, but we have indicated above the most important and those which illustrate to best advantage the convenience and flexibility of electric power for such purposes. There are strong indications of a movement towards the adoption of electric power for all purposes on battleships, and although the British Admiralty is proceeding with great caution in the matter, the fact that a start has been made promises well for the future. We shall devote considerable space in some future issue to the subject, and treat it very fully from the standpoint of our own navy. There is ample scope for big developments in this field, and the problems of adapting electric power to the multifarious operations of a fighting vessel are of the most fascinating character.

Electric Power in Yorkshire.

AFTER being for a year or two on the tip-toe of expectancy of electricity in bulk the Yorkshire manufacturers are at last in possession of a cheap power supply delivered from a station as modern as it can be made. The Yorkshire Electric Power Company has Parliamentary powers to supply electrical energy over an area in the South and West Ridings comprising some 1,800 square miles, this being an important industrial centre in which there are 18 boroughs, 118 urban districts, and 21 rural councils. Four generating stations will ultimately serve this extensive area, but at present that at Thornhill is the only one erected and in operation.

Unlike extravagant municipalities with a

EXTERIOR OF YORKSHIRE ELECTRIC POWER CO.'S STATION, THORNHILL.



Interior Yorkshire Electric Power Co.'s Station, showing Exciters and one 2,000kw. Turbo-Generator.

operates at 1,000 revolutions per minute and has its own condensing plant complete around it. The usual hydraulic footstep bearing is included with an accumulator to furnish water at the requisite 400lb. pressure. The condenser barrel is vertical and fixed beside the turbine, and in conjunction are three throw air pumps, driven by a 15h.p. motor. The Mirrlees Watson Company supplied the condenser outfits.

The alternators furnish three phase current at 50 periods and 10,000 volts, and are excited by separate 150kw. sets driven by Allen engines. The same exciters supply the station auxiliary motors and the electrically operated switch gear. The gallery construction has been adopted for the latter, and the bus-bars occupy the centre gallery. Such refinements as time limits and reverse current relays find no place among the controlling apparatus. Three core cables constitute the main high tension feeders, these being of the paper insulated, lead sheathed, steel armoured type.

bad taste for ornate generating stations, power companies find better uses for their money and house the plant in a building suited to its purpose. An electricity works should never be mistaken for the town hall or cathedral. As our illustration of the exterior portrays, the station is of substantial if unadorned construction, and will easily harbour the plant during its natural life. The boiler house contains six Babcock and Wilcox boilers working at 160lb. per square inch, fitted with superheaters. Coal handling plant is naturally fitted, and the conveyor has a capacity of 25 tons per hour.

The engine room, which is at right angles to the boiler house, is a narrow, steep building, designed to contain 8,450kw. of plant. At the moment, two 2,000kw. B.T.-H. Curtis vertical turbo-generators are in place, and a third is being got into position. Each set

A feature of the supply is the pacific willingness of the rural districts to act as "authorised distributors" from the company's mains. The districts of Pudsey, Mirfield, and Gomersal are already rejoicing in the possession of substations, and Birstall, Soothill, and Liversedge are shortly to be similarly blessed. All these stations, with the exception of Pudsey, have static converting apparatus, reducing the trunk main pressure to 2,000 volts for the urban district council's local single phase feeders. Pudsey station has motor generators giving a low tension direct current supply to a three wire network.

Other large consumers in the shape of mills and factories are also on the mains, and a precedent has already been established in worsted mill driving at Thos. Burnley and Sons, Gomersal, this being the first mill of its kind to be operated from public supply mains.

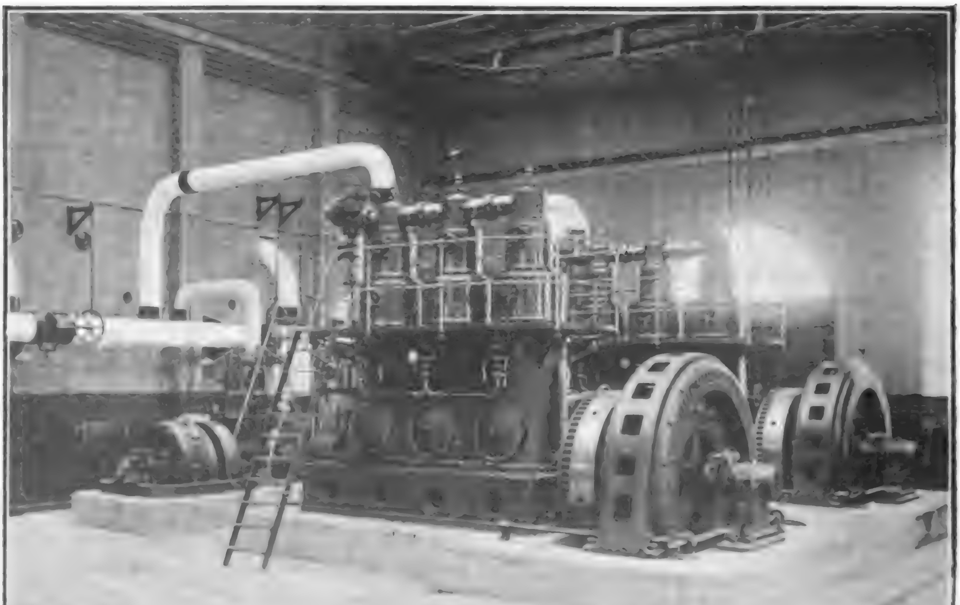
A large load will, it is anticipated, be soon built up, and when it is considered that nearly 3,000,000 horse power is produced in the district by steam plant of various sizes and questionable economy, the campaign before the company promises many engagements and many victories.

Our thanks are here extended to the company's enterprising engineer, Mr. W. B. Woodhouse, for his courtesy in furnishing the information and illustrations which form the basis of this article. We shall take opportunity as the business expands to record interesting developments from time to time.

The Fife Electric Power Company.

An important addition has been made during the past month to the electric power supply companies of Great Britain, in the shape of the initial generating station of the Fife Electric Power Company. The company's Bill was passed during the Parliamentary Session 1903, with authorised power supply to individual consumers outside the area of supply of existing authorised distributors, and in bulk to authorised distributors within the company's area. This includes the whole of the county of Fife, undoubtedly the most important industrial area in the East of Scotland, the 504 square miles being studded with collieries, textile mills, brick and lime fields, quarries, engineering and iron works. These industries are, moreover, so situated as to receive the utmost benefit from a power company operating on modern lines, for they are for the most part scattered rather than grouped closely round any one centre, a condition pointing clearly to high tension transmission. Another source of supply which the company will take up is that to local authorities, mainly for lighting purposes. In the whole area there are at present but two towns, *viz.*, Kirkcaldy and St. Andrews, which have their own supply stations, the former having both lighting and tramways, and the latter lighting only. In view of the great number of towns of small medium size in the county, a large demand may certainly be looked for from this direction.

It is the intention of the Fife Power Company eventually to build several large stations from which the whole of the area can be economically supplied. The first of these, which is really a pilot station, is situated at Townhill, near Dunfermline, and suggested sites for other stations are at Cupar, Leven, and Markinch.



Interior Townhill Station. Fife Electric Power Co. (Willians-Peebles 450kw. Sets and Exciters.)

A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

Operating Costs of the Valtellina Line.

THOSE of our American contemporaries who sighed for operating data of the Valtellina polyphase railway have had their wishes speedily granted, judging by the flood of matter on the subject they are now in a position to publish. As we have already pointed out, the Ganz Company are making a determined effort to introduce three phase traction for main line service into the land of the third rail, and their initial attempts have so far proved encouraging. The next few months should witness some instructive developments in this field, which may be watched with keen interest by railway engineers.

From the names of the contributors to the *Street Railway Journal*, which has recently devoted considerable space to the subject, we may assume that half the Italian staff of the Ganz Company are now quartered in New York. Mr. Bela Valatin, writing to our contemporary, gives the fullest details of the new locomotives employed on the line (we referred to these in our July issue), and with drawings and diagrams makes the construction and motor control quite clear. Fig. 1 reproduced herewith depicts a section through the double motors employed on the new locomotives, from which the novel position of the slip rings will be at once evident. The motor leads are carried through the hollow shaft, round the bend of the crank, and up to the brush holders and slip rings. This construction places the slip rings in a readily accessible position and obviates dismantling any part of the motor to inspect them. Both halves of the twin motors have eight poles, and the speed is 225 normal and 112.5 in cascade. Worked singly the high tension motor only is used, and in cascade the slip rings are out of circuit, as the two motors are inter-connected. A study of Fig. 2 taken from Mr. Valatin's article will make clear the electrical connections of the locomotive. The various apparatus is fully lettered, so that reference in the text is not needed.

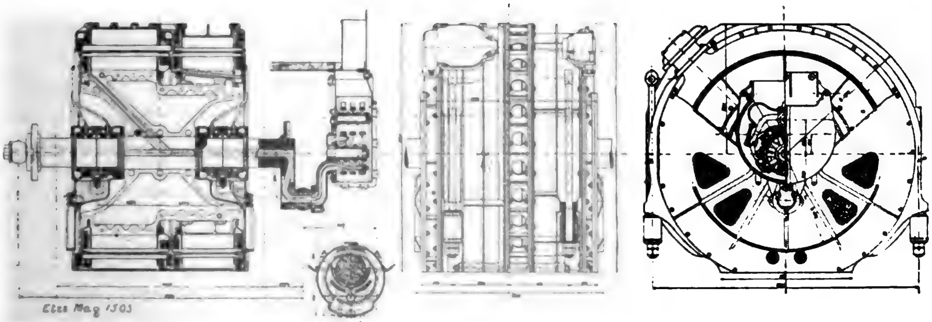


Fig. 1. Section and Elevation of Duplex Three Phase Motor of New Valtellina Locomotive.

The average watt consumption during 1903-04 (July to June) worked out at 71.62 watt-hours per ton mile, this sum including all line and transformer losses, station lighting and accumulator charging from motor generators. Tests were made to ascertain the consumption minus the above losses, and this was found to average 30.2 watt-hours per ton kilomètre. On account of the limited service of trains the peak at the station is about three times the average load for the day, and this affects the results done, and without them other methods would have to be found to make up leeway.

As to cost of operation, Mr. Valatin gives these as 37.8 cents per 1,000 ton km. for the twelve months, during which period some 38,492,585 ton miles were run. Mr. E. C. Cserhati, in a subsequent issue of the same journal, also goes into the matter of costs, and in giving similar figures compares them with an identical length of steam line in Austria, but with 30 per cent. denser traffic. The Valtellina figures are as those stated above,

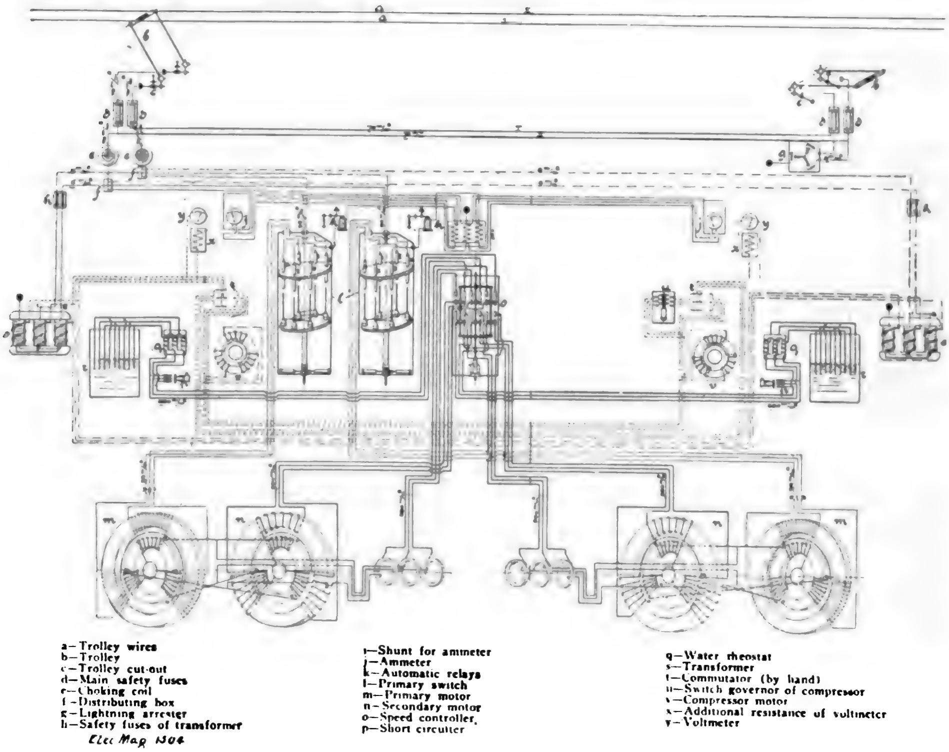


FIG. 2. ELECTRICAL CONNECTIONS OF NEW VALTELLINA LOCOMOTIVE.

unfavourably, especially as both station and substations could easily cope with a larger traffic.

Mr. Valatin then points out that, in spite of their constant speed characteristic, three phase motors admit of making up time on the road. On the Valtellina line this is done by, first, a moderately flexible schedule, which is common to most railways, then running through instead of coasting through stations, and finally by coasting down grades and running up grades at higher speeds. The gradients, of course, admit of this being and those for the steam line equalled 3s. 6d. per 1,000 ton km.

Tests on the Italian line, which have been both varied and numerous, point to the inexpediency of displacing heavy trains by several light trains or cars. It was found that a 120 ton train consumes 31 watt-hours per ton kilo at 60km. per hour on level track, and a motor car running singly required 48 watt-hours, including starting energy. This large difference is due to the air resistance, which is reduced in a much smaller ratio than the train weight.

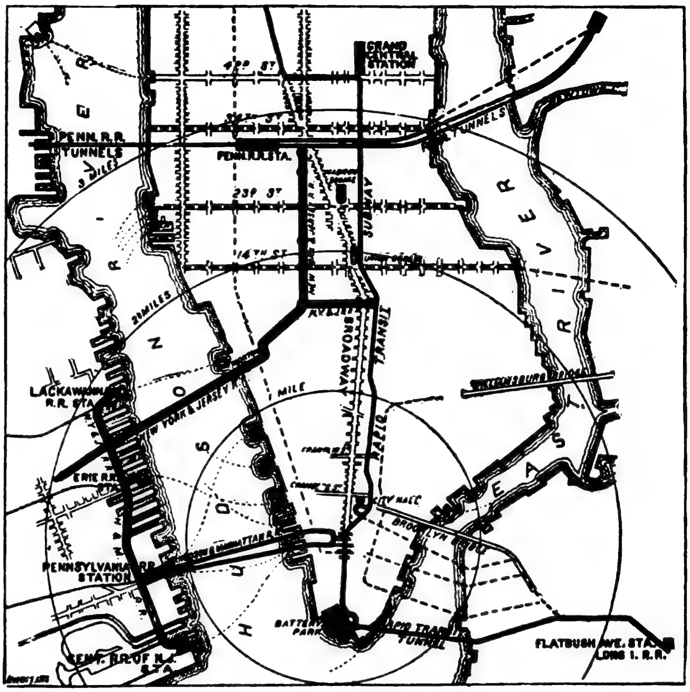
In regard to the recuperation of energy which has been so much talked about, the favourable results on the Valtellina line are directly attributed to its influence. Mr. Cserhati by numerous diagrams indicates the effect of this characteristic of the induction motor on the running results. He states that on a section with a down grade of 2 per cent. a 120 ton train at 30km. per hour will recover 80 per cent. of the energy required for that train. It is recommended that full advantage be taken of this method not only for trains mounting gradients, but for those starting from rest on level sections. For surburban service it is also strongly recommended as with simple cascade the energy recuperated amounts to 35-40 per cent. of that required for acceleration. With the four step cascade connection this regeneration can be increased to the extent of returning more energy to the line at stopping than is lost in the rheostat at starting.

It should be noted that this recovery of energy enables a station of given capacity to operate either a longer line or a denser service than it otherwise would do. Mr. Cserhati's article further gives some interesting comparisons between the energy consumed on polyphase railways and that required for other systems. In these estimates continuous current is considered as unsuited for long distance work, and is omitted entirely from the comparison. We have tabulated the figures given for easier comparison, and it will be seen that they favour the polyphase system in most cases. The Stubaithal line is estimated to give, with polyphase working, an average consumption of not more than 31 watt-hours per ton km. measured at the feeding point, though the consumption on up grades would amount to 57 watt-hours.

TABLE COMPARING ENERGY CONSUMED ON POLYPHASE AND OTHER RAILWAYS.

System.	Location.	Watt-hours per ton km.	Average speed (km. per hour).	Grade up to.
Three phase	Valtellina	44.3	36	2 %
D.c. and a.c. compensated	Schenectady, Ballston	53.5 d.c. 78 1 a.c.	—	Level
One phase	Spindersfeld	45	34.4	2 %
Three phase	Vienna Suburban (projected)	30 7	31	2.9
One phase	Stubaithal	70	27	—

The article concludes with a summation of the advantages of three phase traction, the first item being recuperation, the second "fly-wheel effect" at the station, and the third the full use of the locomotive frame for motors, including the removal of collectors from the motor axles. Only by using the induction motor can these results be obtained, and the polyphase machine of that type is considered best adapted for the work. The variable speed feature lacking with induction motors and once regarded as a drawback was found, in Italy at any rate, to



Map showing Tunnel Developments around New York.
(See next page.)

be an advantage, as the drivers needed less experience and skill. Their duties amounted merely to correct starting and stopping.

These arguments for polyphase railway systems are fairly well known to British engineers, and in one case at least have failed to carry conviction. It remains to watch their influence in America, where railroading is conducted on wider lines than here.

Tunnels and Subways Around New York.

If the original company which undertook in the year 1874 the task of driving a tunnel from Jersey City to Manhattan beneath the Hudson River, and failed, could see the comprehensive system of subways and tunnels which is now being constructed by the Hudson companies, they would at least have the satisfaction of realising that they had inaugurated one of the most important systems of underground railways in the world. When, in the year 1902, Mr. W. G. McAdoo resolved to take hold of the uncompleted tunnel and push it through to the Manhattan side, public interest in the scheme was altogether dead; but realising how great was the advantage that would be conferred by a direct rail connection, and foreseeing how vast would be the growth in popularity of a means of transit that would be so much more comprehensive and expeditious than the ferry system, he not only succeeded in pushing through the original scheme, but he and his associates have extended it on the ambitious scale shown in the accompanying map (p. 155). Briefly stated, the object of the subways and tunnels is to place the great terminal stations of the railroads, in Jersey City, in direct railroad communication with the various business centres on Manhattan Island, so that a passenger on arriving at any one of these terminals can take a train which, in a few minutes' time, will land him, without change of cars, either in the neighbourhood of Lower Broadway and Fulton or Cortlandt Streets or at any point on Sixth Avenue from Ninth to Thirty-third Street, or on Ninth Street from Sixth Avenue to Fourth Avenue. These tunnels will also afford rapid transportation for trolley-car passengers and for thousands who walk to the ferries on the Jersey side from their homes. In the earliest stages of the development of this enterprise it was proposed to utilise these tunnels for running the steam railroad cars of the railroads terminating in New Jersey directly into New York; but as the present companies realised the full magnitude and importance of the enterprise, they very wisely determined to equip the system with the most up-to-date rolling stock and plant, designed especially for its use, and to follow in general the high class of construction which has been used in the Manhattan Rapid Transit subways. The rolling stock, therefore, will be entirely new. The cars will be large and brilliantly lighted; they will be constructed of steel and rendered absolutely fireproof. The protected third rail will be installed, and there will be a complete system of signals of the automatic and semi-automatic type placed throughout the whole line. In the subway on the Jersey City side and under Manhattan, where the service will be local in character, the trains will be run probably at about the same speed as those on the Manhattan subway. In the tunnels below the Hudson River, however, where there are no stops, the trains will be run at express speed. This means that a passenger alighting, say, at the Erie or D., L. & W. or, indeed, any of the terminals, can be in Manhattan in four or five minutes' time, and at Thirty-third Street, Fourth Avenue and Ninth Street, or at Foulton and Broadway, within from five to twelve minutes from the time he takes the tunnel train.

The present condition of the work is that, on the uptown tunnels, the north tunnel is completed from the shaft on the Jersey side to the shaft on the New York side, and the south tunnel is completed from the Jersey side to within 50ft. of the New York shaft. Work is also progressing on the approaches in New York. Of the downtown tunnels, the working shaft on the New Jersey side has been sunk, and the work of driving the two tunnels will shortly be under way, both tunnels being driven simultaneously. It is intended to use the shield method of construction with iron segmental tunnel lining for the whole of the system, not merely for that portion that lies beneath the Hudson River, but also for the subway beneath Jersey City and Manhattan. It is expected that the whole work will be opened to the public in from two to three years' time.—*Scientific American.*

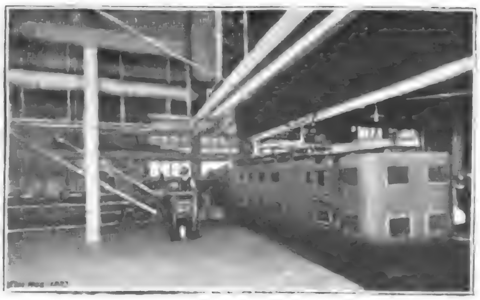
Readers are referred to the World's Electrical Literature Section at end of magazine for titles of all important articles of the month relating to Lighting and Heating.

Niagara Power for Heating.

THE electric heating of bakers' ovens has yet to become an institution in this country, and the chances are very remote of its ever becoming so with the present heating rates on electricity supply mains. At Niagara Falls, however, the thing has been done now for several years. A recent issue of the *Electrical World* contained some interesting data of this unique plant which will make instructive reading for central station engineers troubled with a small day load.

Electricity bakes a pound of bread, says our contemporary, with a consumption of 3,685 watt-hours, in the plant of the Natural Food Co. at Niagara Falls. To bake the same weight of bread in an oven heated by combustion the company uses 0.3306lb. of anthracite coal. Bread in this case is the entire wheat kernel, shredded and then baked without the addition of any other substance. The bread baked with coal is known simply as "shredded wheat biscuit," and the electric baking produces "triscuit."

All mechanical power in this plant is supplied by electric motors, all lamps are electric, and a large share of the baking is done with that form of energy. This energy comes from the plants of the Niagara Falls Power Company, about 3,500ft. distant, in the form of two phase, 25 cycle, 2,200 volt current, and is received in eighteen transformers of 2,300kw. total capacity. Four of these rated at 75kw. each deliver current for incandescent lighting at 115 volts and 25 cycles. Another four of 150kw. each supply 440 volt current to induction motors, and also current for a rotary converter of 220 volts. For the electric ovens there are ten transformers of 140kw. capacity each. Two of these are required for each oven, and there is thus one extra pair. Machinery throughout the plant is driven by 87 induction motors that range from 1 to 40 horse-power in individual rating and have a combined capacity of 560 horse-power. Within an hour after 6.30 in the morning the load rises to more than 700kw., and, with the exception of a drop



Electric Ovens at Niagara Falls.

during the noon hour, ranges from that figure to more than 800kw. until about 5 p.m. After that time it falls in an irregular way to the minimum of 210kw. From all this it may be seen that the mechanical processes through which the wheat passes require rather large powers.

During a certain period the number of shredded wheat biscuits baked by combustion was 1,169,344 dozen. The weight of

LOAD CURVE OF NATURAL FOOD CO.'S FACTORY, NIAGARA FALLS.

each of these biscuits when quite dry was nearly one ounce, or substantially 887,000lb. for the entire lot just named. Biscuits baked with the heat of combustion really pass through two ovens. In the former the biscuits are placed on wire pans which are suspended in a sort of Ferris wheel, so that they revolve slowly for 30 minutes over a great bed of coals, in air and gases that have a temperature of about 450° F.

After this baking process the biscuits are carried slowly through a drying oven that is about 150ft. long and has a temperature of 200 to 300°. The trip from end to end of this second oven takes about one and one-half hours, so that the entire baking process in an oven heated with fuel consumes about two hours. During the same period in which the 887,000lb. of shredded wheat biscuit were baked there were burned in the first or high temperature over 169,000lb. of anthracite coal, stove size, and for the second or drying oven 120,960lb. of anthracite pea coal. The total weight of anthracite coal consumed to completely bake the 887,000lb. of shredded wheat was thus 289,960lb., or 0.3306lb. of coal per pound of wheat product. Of this 0.3306lb. of anthracite coal 0.1927lb. was stove size and 0.1379lb. was pea size. If the anthracite stove coal cost $5 per short ton and the pea coal $3 per short ton, the cost of the fuel consumed to bake one pound of the shredded wheat was 0.0687 cent.

One of the electric ovens for baking the shredded wheat in the form called triscuit turns out about 2,483 triscuit per hour. The weight of these triscuits is substantially ½oz. each, which gives the hourly product a total weight of 77.6lb. Energy consumption in the electric oven varies a little in rate, according to the velocity at which the triscuits are moved through it between series of electrically heated links that do the baking. For each oven there is an ammeter in each phase of the two phase circuit that supplies the electric energy to the transformers at 2,200 volts. While one of the electric ovens was automatically turning out triscuits at the rate above named, the ammeters on observation read 60 and 70 amperes respectively. At 2,200 volts these readings represent an input of 286,000 watts at the primary sides of the two transformers. This rate of work was baking 77.6lb. of triscuits per hour, and the consumption of energy was therefore 3,685 watt hours per pound, including the losses in the transformers. One watt-hour is the equivalent of 3.4383 heat units, so that the 3,685 watt-hours required to bake one pound of triscuit must develop 12,670 units of heat. With perfect combustion one pound of anthracite coal yields about 12,000 heat units, and on this basis the 0.3306lb. of coal consumed in baking one pound of shredded wheat biscuit would develop heat to the extent of 3,967 units. But combustion is never perfect in an ordinary furnace, and as much as 25 per cent. of the heat actually developed escapes with the flue-gases in most cases. It seems most probable, therefore, that not more than 70 per cent. of the latent heat of the coal does any useful work in baking the shredded wheat. This assumption reduces the useful heat to 2,777 units per pound of wheat. If electric energy operating on same material of

high resistance was to replace coal in the furnaces where the shredded wheat is baked by exposure to radiant heat and to hot air, the entire equivalent of the electric energy would be as useful as the 70 per cent. of the latent heat of coal named above. Seventy per cent. of the latent heat of the 0.33061b. of coal necessary to bake one pound of shredded wheat, amounting to 2,777 units, is the equivalent of 807 watt hours. The assumed cost of this coal was 0.0687 cent, and the rate for electric energy to replace the coal at an equal cost is 0.0840 cent per kilowatt-hour. In favour of the electric heat is the fact of a saving as to the labour of handling coal. On this suggestion the shredded wheat would continue to be baked by radiant heat and hot air, and not by contact with heated surfaces.

Photometry of Unsymmetrical Light Sources.

THE lack of symmetry in the radiations emitted from such light sources as the electric arc entail considerable labour and time in photometric measurements. A complete radiation curve over a whole vertical plane was needed with the ordinary vertical carbon lamp, so that matters become very complicated where measurements are taken of later-type lamps, in which the carbons are inclined, and throw the rays downward from the arc. In a recent issue of the *Elektrotechnische Zeitschrift*, Dr. L. Bloch indicates a method of curtailing the labour and yet obtaining accurate results.

The method involves (1) the taking of a light radiation curve in any one vertical plane either over 90% or over 180%, according to the nature of the lamp; (2) the taking of a few readings in two horizontal planes—*e.g.* in the plane of the arc (A, Fig. 1) and in a plane at, say 45% below the arc (B, Fig. 1).

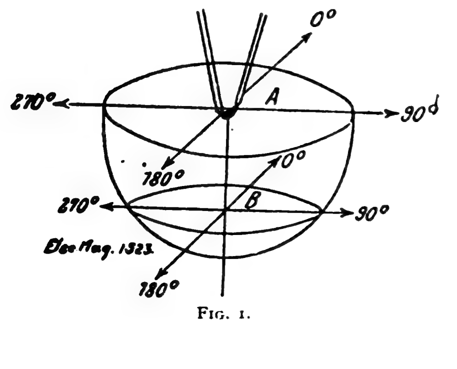


FIG. 1.

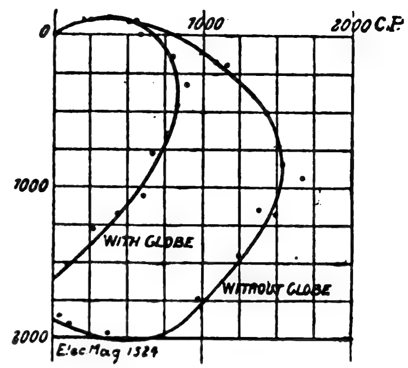


FIG. 2.

Usually four readings for each of these horizontal plane curves are sufficient.

From (1) the mean spherical or hemispherical candle-power for the one particular vertical plane is obtained in the ordinary way.* From (2) the ratio of the average candle-power to the candle-power at the particular vertical plane used in (1) is obtained for each of the two horizontal planes. This ratio will be found to be practically the same for both planes. To obtain the real spherical or hemispherical candle-power of the lamp, it is then only necessary to multiply the mean spherical or hemispherical candle-power for the one vertical plane obtained from (1) by the average value of the ratio obtained from (2).

The simplicity of the method is best shown by an example. Fig. 2 shows the polar candle-power curves taken with and without globe on an arc lamp of the inclined carbon type. The carbons were ordinary (not flame) ones, and were of unequal size (10mm. and 7mm. diameter respectively), so that one was always somewhat longer than the other. This led to an unusually unsymmetrical light distribution. The curves in Fig. 2 were taken for the vertical plane normal to the plane of the carbons. The mean hemispherical candle-powers for this plane calculated from these curves are 1,620 without globe and 980 with opal glass globe. The light distribution in the two horizontal planes, A and B (Fig. 1), was next measured, and is shown in the polar curves in Fig. 3. In order to arrive at the average light intensity represented by these curves, it is not

* It is not even necessary to project the polar curve on to a circle and find the mean ordinate of the resultant curve by planimeter, as quite sufficient accuracy is attained by taking the arithmetical average of, say, 10 equidistant points on the resultant curve.

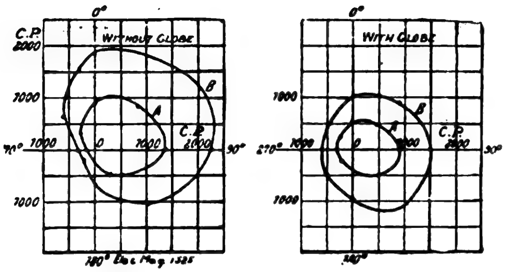


FIG. 3.

necessary to convert to rectangular co-ordinates, as the average of 16 (or even 4) equidistant radial vectors leads to the same result practically. The vertical plane for which the curves in Fig. 2 were obtained is the one marked 0° in Fig. 3. The following table gives the results obtained from Fig. 3:

	Without globe Curve A.	Without globe Curve B.	With globe Curve A.	With globe Curve B.
L_M = Mean candle-power in horizontal plane ... Average of 16 radii .	640	1,260	520	1,030
Average of 4 radii...	660	1,300	525	1,040
L_o = Candle-power on plane marked 0° (Fig. 3)	900	1,860	530	1,050
Ratio $\frac{L_M}{L_o}$	.71	.68	.98	.98

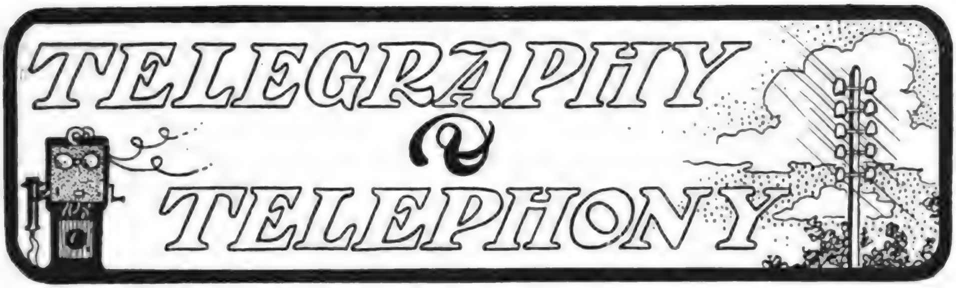
Since the ratio is practically the same for the two horizontal planes tested, it will be safe to assume that it is the same for all other horizontal planes. The real hemispherical candle-power of the lamp is, therefore, obtained by multiplying the hemispherical candle-power obtained from Fig. 2 for the one vertical plane by the average ratio obtained from Fig. 3, or real hemispherical candle-power without globe = 1,620 × .695 = 1,130; real hemispherical candle-power with globe = 980 × .90 = 960. The results obtained are not extremely accurate, but for such a fluctuating source of light as an arc lamp are quite satisfactory.

Lighting Subway Stations.

PASSENGERS travelling by London's tube railways have no cause for complaint of the station lighting. The enlarged diameter of the tube, generously surfaced with white glazed brick, provides both head room for powerful arc lamps and abundant reflection for their rays. The platforms are, consequently, flooded with light. With shallow tramways and subways, however, the case is different. Head room has suffered for erection economics, and only incandescent or Nernst lamps can be resorted to for illumination. The direct consequence is public complaint against the Rapid Transit Company, which makes a good thing out of the subway service. Naturally, when a railway system earns substantial dividends, its patrons expect the governing body to get a move on matters below the standard of public comfort, for which it is directly responsible.

This is the state of things in New York, and our contemporary, the *Electrical Review*, voices the sentiments of Mr. E. L. Elliott on the subject of subway lighting in general and prismatic reflectors in particular. The latter have been unsparingly used in the New York subway stations, and Mr. Elliott makes some caustic references to their employment. Be it put to the credit of the Rapid Transit Company that they have extensively experimented with various reflectors to improve if possible the poor state of the station lighting.

In regard to prismatic reflectors Mr. Elliott details their theory and explodes the notion that painting the exterior surfaces in any way improves the illumination. By diagrams he shows how the rays are reflected back from the inner prismatic surfaces to the source of light, ascribing this feature to the difference in the index of refraction of the glass and air. If the inner surface be, however, coated with a transparent medium of approximately the same density as the glass, reflection will no longer occur. Experiments conclusively proved the superior reflecting powers of a reflector painted white on the inside over one similarly-treated outside. Fir balsam is commonly used to cement compound lenses, and only liquid if brought into contact with prismatic surfaces will prevent reflection. When powders are mixed with liquid any resultant reflection is due to diffusion from the substance used. For this reason the author claims more control of the reflected light variation with prismatic reflectors alone than with such devices painted. By varying the contour of the reflecting surface any desired distribution from a parallel beam outwards can be obtained. On the contrary a diffuse reflecting surface precludes the possibility of this amount of control. It is contended that for the object in view—the lighting of the platforms—diffusion is less necessary than with the car lights, and that the faults of the present system could be largely obviated if the present light sources were provided with the proper accessories.



For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of magazine.

Some Problems in the Wireless Transmission of Signals.

By L. H. WALTER, M.A., Assoc.M.Inst.C.E., A.M.I.E.E.

(Concluded from p. 515.)

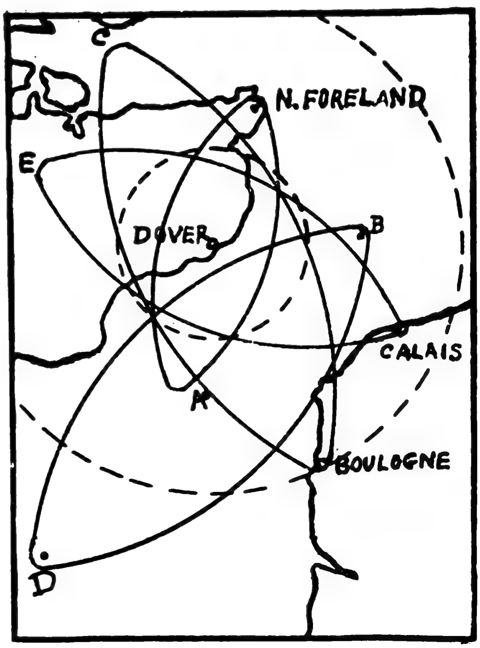
In the June issue two estimates of the improvement effected by Prof. Artom's polarised wave method of transmission were put forward tentatively. In the first the assumption was made that the transmission was of the nature of $(D+x)$ in the desired direction and $(D-x)$ in the direction at right angles to this, where D = distance of transmission by equi-radial (ordinary) methods, and $x = 4D/9$; in the second, taking the energy required for exciting the area of an ellipse with axes of ratio 2.6 as being the same as that necessary to excite a circle of the same area as the ellipse, and assuming no loss due to polarisation of the waves, the saving in energy was calculated to be 65 per cent.

Prof. Artom has been kind enough to confirm the writer's estimates, which he considers proved by the result of his experiments. In fact, trials have shown that the saving indicated in the second estimate is the more closely approximate to that actually realised.

Besides the great saving in power obtainable by the use of the Artom system—which saving can now be taken as a definitely established fact—the limitation of the excited area has at the moment an even greater practical importance in tending towards the solution of the interference problem in a positive and hitherto unattainable direction.

Taking the before-mentioned ellipse with axes of ratio 2.6, and considering, for instance, one typical region where even now messages are numerous, and concentrated within a small area—the English Channel near Dover—a glance at the accompanying map will show what a considerable amount of selective communication could be accomplished without any tuning, and even using the same wave-length in all cases.

Thus, assuming Dover to be transmitting, it will be quite possible to transmit different messages simultaneously in the directions Dover-Boulogne, Dover-Calais, and Dover-North Foreland. Each of these stations would receive its own message without any indication that other messages were about. Also, ships anywhere outside the active ellipses would not be affected, and if situated say at A, B, and D respectively, A would be able to communicate with B or D



Elec Mag. 1395.

without Dover or Calais receiving any trace or their being interfered with (except designedly). The dotted circle on the map indicates the zone of influence on the ordinary equi-radial system. [The points C and E will in reality fall even nearer to Dover owing to the waves travelling over land.] The improvement obtainable by using different wave-lengths and by tuning will still be available, of course, in the same ratio as at present. The best results will be obtained by reducing the transmitter energy to that just necessary to definitely transmit the message, and the largest range of actual usefulness will result from the combined use of the present equi-radial transmission with the polarised wave method—the first for calling up, as in search or distress signals, in cases where the direction of the called station is not known, and the second for limiting the excited area when the idea of direction has been obtained. But these are merely details.

Prof. Artom considers that further experiments will enable the remarkable results already obtained to be considerably improved upon ; yet sufficient has been given to show that the method is not merely another new paper system, but a fundamental improvement in a direction in which no real advance has hitherto been made since the first inception of wireless telegraphy by electric waves. In this connection it may be noted that the Italian Navy has adopted the system in spite of the fact that the Italian Government had previously signed an agreement binding themselves to use the Marconi system and apparatus exclusively for a period of fourteen years (see comments of the Italian technical Press). This fact will show how great an advance this system is held to be. The latest improvement effected relates to means for preventing the waves from spreading backwards from the transmitter, in the direction opposite to that in which it is desired to transmit. The maximum improvement possible by this device would mean multiplying the results already given by 2, or, in other words, these results could be made *twice as good*. It is, however, too early to say what the actual value of the factor is.

Turning now to other problems of the transmission, that indicated by Col. Crompton and previously referred to—the production of continuous trains of oscillations—has been a constant theme on which to dwell, but little has been done in a practical direction. Messrs. Duddell and Taylor have again done service in confirming the view that little can be hoped for from the spark-gap in air (including in vacuo, compressed air, and other gases). In the later experiments described at the reading of their paper, it was shown that increasing the frequency of discharge, by increasing the interrupter frequency, although it increases the power put into the coil, produces no corresponding increase in transmitter energy as evidenced by the receiver; and this result was explained by supposing the gap at the higher rate of sparking to remain partly ionised, whereby the discharge potential was lowered.

The ideal method, of course, is, as Col. Crompton has pointed out, the production of currents of the desired frequency direct from high-frequency alternators, but although this may be possible in the not very distant future, in this paper it is of more concern to consider what can be done towards accomplishing the result by other, though less satisfactory means.

The mercury-vapour gap has been shown by Pierce to give, under the same conditions, four times as great an energy effect at a distance as was obtainable with a spark-gap in air. Another property which gives the mercury-vapour gap very great advantages over the spark-gap in air is its extraordinarily rapid rate of recovery ; its resistance is also low and extremely constant. Unfortunately, no results are available which relate to experiments made over longer distances, but sufficient work has been done to show that a considerable advance is capable of being realised by the suitable employment of the mercury-vapour gap. In this connection it may be observed that P. Cooper Hewitt has devised a very persistent oscillator employing the mercury-vapour principle.

Considerations of space necessitate the concluding of an article which has already exceeded the intended limits, but it is impossible to do so without briefly referring to recent results in selective reception. Thus, Capt. Jackson stated in the discussion on Messrs. Duddell and Taylor's paper, that on the "Vernon" at Portsmouth it was possible to receive signals from Poldhu on one mast and at the same time to receive another message from a nearer station on the other mast, there being no interference between the two messages. This result, though considered wonderful, does not, however, appear to be nearly as remarkable at first sight as

the fact that ships or stations provided with ordinary ship-signalling apparatus are unaffected by the waves from the mammoth station, even when quite near Poldhu. Both of these results, on examination, are reduced in value by the fact that the wave-lengths employed in the two cases are so very dissimilar. It is well known, and was demonstrated even in 1902 by Signor Marconi and also by Prof. Slaby, that selective simultaneous reception is quite easy provided the wave-lengths can be suitably chosen and are very different.

Prof. Fessenden, on the other hand, with his selective system, in which the frequency of the waves is changed (such changes of frequency constituting the signals) and not the intensity, has obtained far more remarkable results in tests made before the United States Navy Board at Washington Navy Yard. In these trials, made on August 23rd of last year, three 2h.p. stations with masts forty metres high, located at distances of 5 miles, 1,000 yards, and 300 yards respectively from the receiver station, and one 10h.p. station only 174 yards from the receiver were all operated at full power for the purpose of producing interference, and yet only the 10h.p. station was able to prevent the reception of messages. This test is far more severe than anything which is likely to occur in practice, and the results may fairly be considered the best which have hitherto been obtained in selectivity.

Telegraphy Correspondence Class.—VII.

Conducted by CICERONE.

THE scope of the Correspondence Class is not so circumscribed as to preclude any of our students from addressing questions either of interest to others or pertaining to their own advancement. We welcome such letters as we have received from "Treyar" and "Pelmar," and will always be ready to give them what assistance we can.

The fifth exercise has not produced such a good crop of answers as formerly—due, no doubt, to the scanty notes which accompanied them. Owing to the exigencies of space these notes had to be considerably curtailed in the June issue, and were unavoidably crowded out in the July number, notwithstanding its increased dimensions. As they are of importance to students of construction, and are not easily accessible to them from the average text-book, they are given now in a little greater detail.

Insulators are dependent upon their form and their material for efficiency. The material offering the greatest resistance is the material that affords the greatest obstacle of escape to the current.

Having settled the best substance for insulating purposes, it then becomes a question as to the best form. In the case of the conductor it is desirable to select the best conducting material, with a minimum length and a maximum cross section, but it is desirable in insulating to choose the material of highest resistance, and to give it such form as to present the maximum resisting surface to the escape or leakage of current. The best insulators, or, in other words, the worst conductors, are dry air, glass, ebonite, paraffin, gutta-percha, india-rubber, porcelain, earthenware, &c.

Of these air is difficult to obtain always in the dry state, glass is too hygroscopic, ebonite crumbles away owing to evaporation, and the same may be said to some extent of india-rubber and gutta-percha. Porcelain and earthenware therefore remain as the best materials for insulators.

The insulators of Cordeaux and Langdon are among the best, but there are hundreds o others all constructed upon the same genera principles.

Supports may either be of metal or of wood, but the former is little used in this country except in cases where æsthetic tastes demand it. Iron, which is the metal mostly used, is more expensive than wood, but is stronger and more durable. Its insulating property is not so high as that of wood, and its influence as a conductor, in close proximity to the line, tends to increase the electrostatic capacity of the line. Supports, whether of iron or of wood, must be sufficiently strong to withstand the crushing or static and kinetic or dynamic strains to which they are subjected.

Every material has a certain coefficient of rupture or breaking weight, which is obtained by experiment.

For instance, iron has from 65cwt. to 80cwt. per cubic foot according to its quality and mode of manufacture. brass has 24, ash and oak have about 16 each, and pine from 7 to 11, varying in different countries.

For rectangular beams the following formula will give the breaking weight, W, approximately in cwts.:

$$W = \frac{KBD^2}{L}$$

Where W = Breaking weight in cwts.
B = Breadth of beam in inches.
D = Depth of beam in inches.
L = Length of beam in inches.
K = Coefficient of rupture or breaking weight in cwts. per unit length.

This formula varies for different sections and

according to how the weight is applied. It is true for beams fixed at one end and weighted at the other, but for beams fixed at one end and the weight or stress distributed along its length it becomes—

$$W = \frac{2KBD^2}{L}$$

and for beams supported at both ends and weighted at the centre—

$$W = \frac{4KBD^2}{L}$$

With the ends supported and the stress distributed—

$$W = \frac{8KBD^2}{L}$$

With the ends fixed and the stress applied at the centre—

$$W = \frac{6KBD^2}{L}$$

and with both ends fixed and the stress distributed—

$$W = \frac{12KBD^2}{L}$$

In short, by distributing the stress the breaking weight is doubled, and by fixing, instead of merely supporting the ends, the breaking weight is increased one and a half times. The first condition, *viz.*, fixed at one end and the stress applied at the other, is the one that most nearly resembles a telegraph pole fixed in the ground at one end, and having the stress of the wires applied at its other extremity.

But the formula also varies for different sections and becomes, for a circular pole—

$$W = \frac{K4.7R^3}{L}$$

where R = the radius of the section.

For a hollow circle—

$$W = \frac{K4.7\ R^4 - r^4}{RL}$$

where R = the radius from the centre to the outer surface and r = the radius from the centre to the inner surface of the section.

For an elliptical solid section—

$$W = \frac{K4.7\ Rr^2}{L}$$

where R = the broad radius and r = the narrow radius.

For a hollow rectangular beam,

$$W = \frac{K(BD^3 - bd^3)}{DL}$$

where B = total breadth of section.
D = total depth of section.
b = breadth of hollow part.
d = depth of hollow part.

A little study will show that W is greatest for solid round timber, the loss in the breaking weight of square or rectangular beams being due to the severing of so many rings in squaring the wood. The uncut rings offer a high resistance to rupture, or tensile fracture, whereas the fibres that are cut do not, although they do resist against splitting.

For the benefit of telegraph engineers tables are prepared giving the breaking stress for unit length of any class of timber from which the breaking stress of a beam, any length, can be readily calculated simply by dividing the constant, K, by the length of beam in feet.

The length of a telegraph pole for this purpose is measured from the ground line, which is the point of support, to a position called the resultant point, situated midway between the top and bottom wires supported by the pole.

The first part of the first question in the fifth exercise regarding the relative advantages of certain metals for overhead wires has been fully answered in previous notes, and all the replies received have been very complete. Briefly, the points to remember are: copper, although somewhat dearer than iron, is quite as strong and is proof against atmospheric chemical attack. It has fully six times better conducting power, has commensurately less electrostatic capacity, and has no electro-magnetic inertia.

Aluminium is dearer than copper and is not so strong, but is proof against oxidisation. Weight for weight it has about the same resistance as copper, but is so light that its superficial area for a given resistance becomes considerable, and consequently its electrostatic capacity is increased. It has no magnetic inertia, but is difficult to joint.

Bronze, both silicium and phosphor, has a greater breaking weight than copper, but its resistance is about $2\frac{1}{2}$ times greater.

The tests to which copper wire is subjected are (1) ductility; (2) torsion; (3) tensile; and (4) conductivity. The first consists of wrapping a piece of the wire six times round its own diameter, then unwrapping and again winding and unwinding a similar number of times in the same direction without fracturing. In torsion it must, in a given length, be capable of standing a certain number of twists according to its diameter, without splitting; and its tensile strength must be such that it will sustain a certain strain without injury. The resistance test is applied by comparing a certain length at a temperature of 60° F. with some standard resistance.

The breaking stress of a red pine pole 20ft. long and 10in. in diameter may be found from the formulæ given above, but "Treyar" has worked it this way, which appears to allow for a factor of safety:

$$S = \frac{adK}{8l}$$

$$= \frac{10^2 \times .7854 \times 10 \times 5.350}{8 \times 20 \times 12} = 25\text{cwt. nearly}$$

where S = breaking strain,
a = area,
d = diameter or depth,
l = length,
K = modulus of rupture (5,350 for red pine);

and when the pole is square

$$S = \frac{adK}{6L}$$

$$= \frac{10^3 \times 5,350}{6 \times 20 \times 12} = 33\text{cwt. approx.}$$

$33 - 25 = 8$cwt. stronger.

The third question has been treated in the notes above, and it may be said that the two best methods of preserving wood are creosoting and boucherising. Of insulators the best are the double shed form, and preferably those of the Cordeaux pattern, while porcelain is the all-round best material.

Regarding the manufacture of wire, which constitutes the theme of the fourth question, sufficient has been said in the notes already given, but particular note should be made of the precautions necessary to guard against electrical and mechanical flaws. In the case of iron wire manufacture the expulsion of foreign ingredients is the main consideration, and with regard to copper the same holds good, the presence of arsenic being especially deleterious; but it is also essential to exclude air currents when the metal is in the molten state. The slightest trace of arsenic not only affects its mechanical properties, but it increases its resistance by about 40 per cent., and the admission of air during manufacture also adds greatly to its resistance.

The breaking strain of a wire 200 mils in diameter the material of which is quoted at 20 tons per square inch can be calculated by simple arithmetic

In this way one student solves the problem:

Sectional area of wire $= .2 \times .2 \times .7854 = .031416$

Breaking strain of wire 1 square inch $= 25$ tons

" " " " .031 " " $= 25 \times .031$
$= 15.7$ cwt

Equally simple is the following:

The breaking strain of a wire varies directly as its cross section. The cross section of a wire 200 mils in diameter $= .2 \times .2 \times .7854$
$= .031416$ square inches.

$\therefore$ Breaking strain $= .031416$ of 25 tons
$= 1,759$lbs.

The second moiety of this question has apparently proved rather perplexing, as some competitors have evaded it altogether, while others have approached it in a half-hearted kind of way.

"Treyar" has boldly tackled the problem, but is doubtful about the result.

On a terminal pole (which must of necessity be amply strutted or stayed) the static stress is longitudinal and is the sum of the stresses of the separate wires.

This horizontal pressure, P (in cwts.), multiplied by the distance, d, between the ground line and the resultant point (in feet) gives the total stress, W, in foot-cwts., and is directly comparable with the breaking stress of timber as given above:

$$W = P \times d$$
$$= 170 \times 20 \times 22$$
$$= \frac{170 \times 20}{112} \times 22$$
$$= 670 \text{ foot-cwts. nearly.}$$

The final question has evidently not been found a formidable one by the majority of competitors, as nearly all the answers are correct.

"Pelmar," as usual, although unfortunately he has not been in the best of health recently, has reasoned the first part in this manner:

"The line has $222 \times 25 = 5,550$ insulators, therefore the total insulation resistance $= 5,550$ insulators of 2.5 megohms each in parallel

$$= \frac{2,500,000}{5,550} = 450 \text{ ohms."}$$

"Treyar" proves the same in less compass, thus:

"Insulation resistance per mile $= \frac{2.5}{25} = 0.1$ megohms; total insulation resistance $= \frac{0.1}{222} = .00045$ megohms."

He also succeeds in solving the latter half i as easy a way:

Number of poles per mile $= \frac{1,760}{20} = 88.$

Insulation resistance per mile $= 300 \times 5,000$
$= 1.5$ megohms.

Insulation resistance per insulator $= 1.5 \times 88$
$= 132$ megohms

But "Pelmar" surpasses him for brevity. He puts it in this way:

The line has $300 \times \frac{1,760}{20} = 26,400$ insulators.

Total insulation $= 5,000$ ohms

$\therefore$ insulation per insulator $= 5,000 \times 26,400$
$= 132$ megohms.

The stresses to which an overhead telegraph line is exposed are (1) static, and (2) dynamic or kinetic.

Static strains proper are those due to the crushing stress of the wires and mountings and those experienced on a long grade in hilly districts; but there are others due to the tension of the wires and to sudden shocks from falling trees and broken wires. These are generally in a longitudinal direction. Dynamic or kinetic stress is felt laterally, and is due to wind pressure. In the work of construction both of these classes of stress have to be provided against. This is done by selecting supports of sufficient strength, and strutting or staying them by means of suitable material.

On a terminal pole the longitudinal static strain is simply the sum of the stresses of the separate wires applied at the resultant point, or point midway between the top and bottom wires. On intermediate poles this strain varies between the extremes of poles in a straight line and poles at an acute angle.

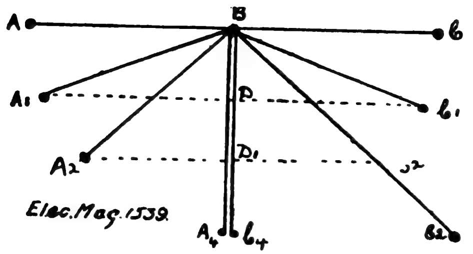


Fig. 1.

When in a straight line, A B C (Fig. 1), the strain in the direction B A counterbalances that in the line B C, so that the pole B is not influenced.

As the poles deviate from the straight path, the transverse strain on B increases from a minimum at A B C to a maximum at A_4 B C_4 when both the wires run parallel, or, in other words, the transverse strain increases with a diminution of the angle A B C (Fig. 1).

To ascertain the stress at any angle, measure off a length (l), B to D, on a line drawn parallel to A B C. Each wire span, L, has a certain stress, W, on B.

Then $L : l :: 2W : x$

since W is applied by both spans of wire.

Let L = 200ft.

l = 10ft.

W = 300lb.

x = the transverse strain.

Then 200 : 10 : : 600 : 30

or 30lb. strain on the pole B.

When the spans are unequal in length, measure off a length, B C_2, on the longer span, equal to the shorter span, B A_2, and strike the line, B D , between these points.

Then $x = 2$ S cos. $\frac{1}{2}\,\delta$

where S = stress of each span,

δ = angle formed by wires.

For the convenience of telegraph engineers, tables are prepared by which the stresses for all angles and weights of wires can be readily calculated. These tables are prepared on the basis of a maximum s ress of 300lb. for each 400lb. wire. The actual stress is only 270lb., but an allowance of 30lb. is allowed for an average snow accumulation at freezing point. This allowance is deemed sufficient, because the increase in length due to the elasticity of the metal, under additional weight, gives an increase of sag, and a consequent decrease of stress.

The static strain, S (in foot-cwts.), tending to cause rupture at the ground line of an unstayed pole = W d,

where W = the horizontal static stress in cwts.

and d = the distance between the ground and the resultant point in feet.

Dynamic stress is due to horizontal wind pressure, and varies as the square of the velocity of the wind. A brisk wind of about 20 miles per hour gives a pressure of about 2lb. per square foot, while a hurricane of 100 miles an hour gives nearly 50lb. per square foot.

These are only approximations, which vary also with altitude. For practical purposes the average height of the wires is taken as 20ft. and the wind pressure as 17lb. per square foot of exposed wire. The wire being of circular section, the effective area is only about two-thirds of its diameter.

On this basis tables are prepared showing the effective wind pressure on lines, by comparing which with those dealing with the strength of timber, poles of suitable scantling may be selected.

The lateral wind pressure is a factor that must therefore be considered as well as the moment of pressure at the ground line, in the determination of suitable stays and struts, and of A and H poles.

When the static and kinetic stresses at the resultant point of a pole are known, the effective strain on a strut or stay can easily be calculated by the triangle of forces. The pole, the stay, and the ground line form a triangle. If now one side of the triangle be made to represent a force acting parallel with it, the other sides will represent the other forces.

Let B C (Fig. 2) represent the stress, A W, due to all the wires tending to pull over the terminal pole, D E, and x the strain on the stay.

Then B C : B A : : A W : x

where B A is the length of the stay and B C the distance between the foot of the pole and the anchored stay.

If the length of the pole from the ground line, C, to the resultant point, A, where the stay is attached, and the distance C to B are known, the length of the stay A B can be calculated thus :

$$A\,B = \sqrt{A\,C^2 + B\,C^2}$$

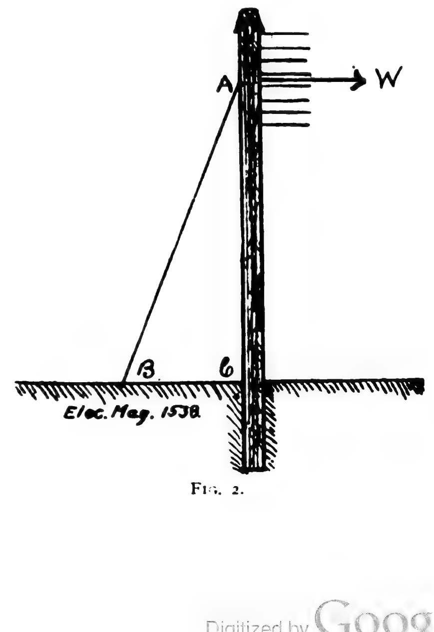


Fig. 2.

Example.—A 30ft. pole buried to a depth of 6ft. measures 20ft. from C to A.

$$\text{Then A B} = \sqrt{20^2 + 10^2} = 22{,}36\text{ft.}$$

If the pole carries ten 400lb. wires, each exerting a maximum pull of 300lb., the total

$$\text{pressure, A W,} = \frac{300 \times 10}{112} = 27\text{cwt. nearly.}$$

$$\text{Then} \quad 10 : 22.36 :: 27 : x$$

$$x = \frac{22.36 \times 27}{10} = 63.7\text{cwt.,}$$

from which it will be seen that the farther the stay is anchored from C the less strain it has to bear, and the more effectively it acts.

On an intermediate pole, B, forming an angle with two other poles, as in Fig. 1, the static and the dynamic forces must be counterbalanced by strutting or staying, and a support provided of adequate strength for resisting both of these impressed forces.

The calculation of these forces is comparatively easy:

Let B D represent the distance out of the straight line, and B A_1 and B C_1 the length of the spans of wire on either side of B. Each of the ten wires exerts a strain of 300lb.

Then B A_1 : B D :: A W : x as before.

If the spans are each 50yd., and the distance from B to D is 10ft.,

$$\text{Then } 150 : 10 :: 2 \times 10 \times 300 : x$$

$$\text{and } x = \frac{60{,}000}{150} = 400\text{lb.} = 3.6\text{cwt. nearly.}$$

This represents the transverse pressure of the two spans, A_1 B and B C_1, acting on the intermediate pole, B.

But there is also the dynamic stress due to wind pressure to be considered. Acting horizontally, the wind effect on only one span is taken into consideration, and the total area, A, exposed = $l \times \frac{1}{12}d \times n$,

where l = length of one span.
d = diameter of wire.
n = number of wires.
a = area exposed to wind pressure.

The stress, z, then due to an average wind pressure of 17lb per square inch = $17 \times A = z$, and the total stress when the dynamic and static forces are acting together = $x + z$

This total stress multiplied by the distance, d. from the ground to the resultant point is a measure of the pressure in foot-cwts, W, tending to cause rupture at the base of the pole or

$$W = d\,(x + z).$$

If the pole is stayed or strutted the stress on the stay must equal the total horizontal stresses multiplied by the ratio of the height from the ground to the resultant point, A C, and the length of the base line between the pole and stay, B C. In the case already considered the stress on the stay $= (x + z)\,\dfrac{A\,C}{B\,C}$

When the stay is not fixed accurately at the resultant point, multiply the strain by the actual height of the stay and divide by the height of the resultant point.

It is not safe to use supports, &c., merely sufficient for their maximum load; some margin or factor of safety must be allowed in case of fluctuations in the load or of sudden shocks to the structure.

Even ordinary structures, which are not exposed to sudden violence, are given as high a factor of safety as 4, but where sudden shocks are liable this factor is raised to from 8 to 12. In the case of telegraph poles 10 is what is allowed without regard to snow accumulation. For wires, the margin agreed upon is only four on account of the safety derived from the elasticity and ductility of the wire itself, and the deflection of the poles under the influence of wind pressure. The dip of the wire increases with added weight, and the strain thereby diminishes.

It is impossible to stretch any flexible material perfectly straight before it breaks; each span of telegraph wire must therefore hang with a curve or bend, formed by its own weight, called its catenary. The largest dip is called its sag, a factor which depends upon the strain or tension with which the wire is pulled up.

Given the weight and length of span, the dip may be calculated thus:

$$d = \frac{l^2\,w}{8\,s} \quad \text{or} \quad d = \sqrt{\frac{3\,l\,(L - l)}{8}}$$

The maximum tension to which wires are drawn is a quarter of their breaking weight, and since the stress depends directly upon the square of the length, it will depend inversely upon eight times the dip, or $s = \dfrac{l^2\,w}{8\,d}$

where l = length of span in feet.
d = dip or sag in feet.
w = weight in lb. per foot.
s = stress or strain in lb.

A 200lb. copper wire has a breaking stress of a little over 700lb., or that which would support vertically a length of over three miles without breaking.

If the full weight per span is given

$$d = \frac{w^2}{8\,s}$$

The principal cause of variation in the sag, and also in the stress, is change of temperature.

To find the dip. d_1, at a higher temperature than that at d, the following formula is useful:

$$d_1 = \sqrt{d^2 + l^2\,(t \times \tfrac{3}{8}\,k)}$$

and $s_1 = s\,\dfrac{d}{d_1}$ where s_1 = stress at higher temperature, t = difference of temperature, and k = coefficient of expansion of the particular metal (k for iron = .00000683 and for copper .00000956 per ° F.).

The length of wire, L, in a span, l,

$$= L = l + \frac{8\,d^2}{3\,l}$$

All the fittings of a pole except the insulators are fitted before planting. It is then raised in a line with the wires and buried to about a fifth of its length in a rectangular hole, dug in line with the wires, unless it has been bored round by means of some borer for the purpose, to suit the diameter of the pole. The latter plan gives the firmest bedding, but cannot be done by such simple implements as a pick and shovel.

If the pole is to carry a cap or saddle wire, the saddle is fitted over the galvanised iron roof before erection, and the arms, of seasoned oak, are bolted into grooves on the up side of the pole. For ordinary telegraph lines long and short arms are used alternately, the long one being uppermost, so that a wire disengaged from its insulator may fall clear of the line below. Nine inches separate the uppermost arm from the top of the pole and 12in. divide the others from centre to centre of the bolts. On lines carrying a great number of heavy wires, A or H poles, as they are called from their shape, are employed and are fitted with longer arms.

The two poles forming the A are scarfed and joined at the top so that the pair form an isosceles triangle.

H poles are used for telephone trunk lines, and are erected at a uniform distance of from 18 to 24in. apart, supported by trellis-work.

The insulators are fitted before the wiring begins.

A ratchet and dynamometer are used for gauging the proper tension to give to the wire, which is then laid in the groove of the insulator while it is bound thereto with suitable binding wire. Joints in the wire are made in this country by laying the two ends side by side, and wrapping them round with binding wire and carefully soldering. This form is called the Britannia joint, but there are various others, of which the latter-day ones aim at eliminating the necessity for soldering, the soldered joint being always a source of weakness.

The position of struts and stays is determined when the line is first of all surveyed.

A stay takes up the pull or tension of the forces acting on the pole, while a strut resists the impressed forces as well as takes up the pull.

Generally speaking a strut is only used when it is inconvenient to apply a stay. The stay consists of a number of wires twisted into the form of a rope having the required breaking stress. Its upper end is stapled to, and spliced round, the pole at the resultant point, while its lower end is fitted to an adjustable rod, whose other extremity is bound to a wooden block buried from 3 to 6ft. in the ground, the hole being undercut so that the firm earth resists the upward pull. Stays must be kept absolutely clear of the lines, and whenever there is danger in this respect forked or spurred stays are made use of.

Struts are made from old poles, and are fitted by scarfing one end so as to neatly fit the curvature of the pole, and banking the other end against the earth, or inserting a base block between the foot of the strut and the pole.

Terminal poles are made of square stout Memel pine, well seasoned, charred and tarred well above the ground line, the remaining part being painted. Creosoted poles are not used owing to their destructive effects on the gutta-percha of the insulated wire used for in-door purposes. A specially strong insulator and bolt are used, and the arms are fitted longitudinally or in line with the wires and with the back portion cut off. Leading-in cups are fitted between the arms on each side of the pole, and take up the uncovered wires from the insulator, and connect them with the covered leading-in wires contained in a covered through, either cut in or attached to the pole.

EXERCISE VII.—SEPTEMBER, 1905.

1. (*a*) What are the stresses to which an overhead line is exposed, and how are they met?

(*b*) What is the static stress sustained at the base of an unstayed terminal pole carrying twelve 400lb. wires, each exerting a pressure of 270lb.?

2. (*a*) What are the relative sags of two similar wires of 60yd. and 100yd. span respectively, if they have the same stress?

(*b*) Find the relative strains on two wires having 80yd. and 120yd. span, and 5in. and 10in. sags respectively.

3. (*a*) The sag on an 80yd. span of 400lb. wire is 2ft.; what is the stress?

(*b*) By how much is the length of wire increased if the sag changes to 3ft.?

4. (*a*) If the breaking strain of a wire is 1,250lb., what will that of a wire of the same metal but half its diameter be?

(*b*) Compare the breaking weight of a round, a square, and an octagonal pole, of similar lengths and diameters.

5. (*a*) What length of copper wire is required per mile on a line having an average dip of 1ft. per span of 80yd.?

(*b*) By how much will the wire stretch if the temperature rises 5° F.?

6. (*a*) What is the horizontal stress on a mile of wire due to a steady lateral wind pressure of 20lb. per square foot?

(*b*) Find the stress on the stay of a terminal pole carrying 15 wires of 300lb. pressure each, if the stay is anchored 10ft from the pole, and attached at the resultant point 24ft. from the ground line.

NOTE.—Question 5 (*b*) may appear formidable. The following additional formula may be of assistance:

$$d_1 = d\sqrt{\frac{L\,(1 \times k\,t) - l}{L - l}}$$

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of magazine.

*A Chat about Accumulators.**

By S. R. BOTTONE.

(Concluded from p. 101.)

At first the extrication of gas is but small; but as the operation proceeds it becomes greater, until towards the end the fluid becomes milky in consequence of the innumerable bubbles by which it is permeated. At the same time, it will be noticed that the surface of the other sheet or plate, *viz.*, that coupled up to the positive electrode, soon changes colour, acquiring a deep chocolate brown tint. This is due to the fact that the oxygen gas liberated during the decomposition of the water enters into combination with the lead positive plate, forming therewith a body known as "lead peroxide." If we represent water as H_2O (that is to say, two atoms of hydrogen and one of oxygen, lead being symbolised by Pb, plumbum) we may figure to ourselves the change effected by the passage of the current through the molecules of water as expressed graphically below:

$$2H_2O + Pb = 2H_2 + PbO_2;\ \text{or in words:}$$

$$\left.\begin{matrix}\text{2 molecules}\\\text{of water}\end{matrix}\right\} \;\&\; \left\{\begin{matrix}\text{1}\\\text{of}\\\text{lead}\end{matrix}\right\} \;\begin{matrix}\text{give}\\\text{rise}\\\text{to}\end{matrix}\; \left\{\begin{matrix}\text{2 molecules}\\\text{of}\\\text{hydrogen}\end{matrix}\right\} \;\&\; \left\{\begin{matrix}\text{1 molecule}\\\text{of lead}\\\text{peroxide.}\end{matrix}\right.$$

If, now, connection be broken between the source of electricity and the cell, the two terminals being then joined by a wire or other conductor, the two gases, separated by the strain put upon them by the charging current, enter again into combination to reform water; while the energy taken up by them, to enable them to exist in the gaseous state, is now evolved in the form of electricity, which will be found to flow from the terminal, P, through the wire (or other conductor) to the terminal, N. At the same time, if this discharging process be kept up for a sufficient length of time, the brown colour of the positive plate or sheet loses its intensity, owing to the deoxidation of the lead peroxide.

5. It is not our intention to give here a detailed account of the many modifications which the accumulator has undergone in reaching its present state of efficiency; suffice it to say that the efforts of inventors have been directed to compass two main ends: firstly, to render the operation of "charging" at once more expeditious and less costly, by availing themselves of the possibility of setting up the "strained" condition of the two opposing plates by chemical rather than by purely electrical means (1); secondly, to making the plates of high conductivity, and as light as possible consistent with sufficient strength to bear the strain caused by the molecular changes occurring during the charging and discharging processes. To attain the first desideratum it is now customary to cast the lead plates in the form of rather thin grids, having numerous perforations, these perforations being afterwards filled in with compositions, or "pasted" with materials, which have as nearly as possible the same chemical composition as the bodies which would result from a long continued "charging" current being passed through the cell containing the plates. For the negative plates or grids, this paste consists of finely divided metallic lead, such as may be prepared by immersing strips of clean zinc into a saturated solution of lead acetate (sugar of lead) in water slightly acidulated with a few drops of nitric acid or of vinegar. A chemical reaction takes place, the zinc is

dissolved by the acetic acid of the lead acetate, while the metallic lead is freed in the form of minute crystals, which possess the property of agglomerating if pressed together. This precipitated lead, when sufficient has been deposited, should be collected and kept under water until required for use, when it should be pressed into the perforation of the grids by the aid of a wooden spatula. The negative grids should then be set up to dry. They now consist practically of highly porous metallic lead in contact with the metallic framework of the leaden grid, and therefore approximate very closely in texture and composition to the negative plates of the Planté cell after being acted on by the current. We have seen that the condition attained by the positive plate of the said cell under the influence of the charging current is the conversion of the metallic lead to the state of lead peroxide, to a greater or lesser extent By making a paste of dilute sulphuric acid (equal parts of oil of vitriol and water) along with good red lead, a considerable amount of this latter is converted into lead peroxide. The perforations in those grids intended for "positives" are to be filled in with this paste, allowed to dry thoroughly, and then be plunged into a strong solution of chloride of lime in water, which will still further bring about the change of the red lead into lead peroxide, as shown by the chocolate brown colour acquired by the plates thus treated. After about two hours' subjection to this treatment with chloride of lime solution, the plates should be removed, carefully washed in running water, and then reared up to dry for about fifteen hours, when they will be ready for placing in their cell To prevent either of the pastes from falling out of the perforations when the accumulator is at work, it is usual to give these perforations the shape of inverted cones; that is to say, they should be larger at the central portions of the plate or grid than they are at the outsides, as shown in our Fig. 3, where a section of a plate is illustrated. The numerous perforations made in the plates conduces to render them lighter than if they were constructed of solid lead, while the innumerable points of contact with the pastes favour good conductivity. By adding a small quantity of antimony to the lead before melting and casting, considerable strength and rigidity is imparted to the lead, but antimony must be used in moderation, because pure lead is found to act better electrically than when alloyed with antimony. To facilitate the coupling up of the separate grids to one another or to the terminals, it is usual to cast the grids with lugs at one of the upper corners. In joining these to other grids or to the terminals, the junctions should be made with pure lead, by autogenous burning, since, if solder were used for this purpose, it would quickly be corroded by the galvanic action set up between the two metals, and the grids would become detached.

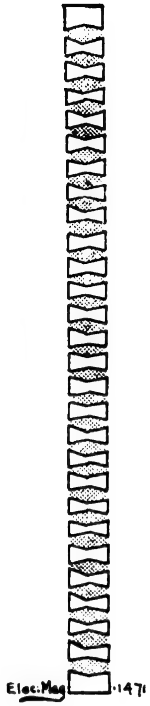


Fig. 3.

6. The intelligent reader will have observed that, although by the processes indicated above it is possible to render the grids as nearly as possible identical in chemical composition to that possessed by the lead plates that have been subjected to the action of the current, yet they differ from these latter inasmuch as there are no bubbles of *free* oxygen or *free* hydrogen adhering to their surface. Although such plates, if immersed in acidulated water, would furnish current for a short time, yet partly owing to the reason just alleged, and partly to their want of porosity, the action would be only

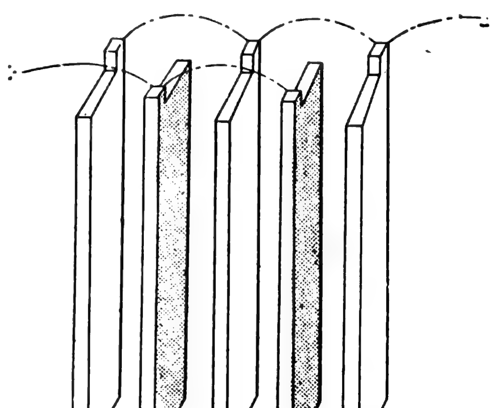


Fig. 4.

superficial, and the supply of current would soon be exhausted. In mounting the plates in their cells (which for motorists' use should be preferably made of transparent celluloid) it is well, in order that *both* sides of the *positive* plate should be active in supplying current, that there should be one *negative* in excess of the number of positives used, these being arranged sandwich fashion, as shown in Fig. 4, with a small space between each plate. In our illustration, the shaded sections represent the positive, or + plates, while the unshaded sections stand for the negatives. The figure shows the arrangement adopted for a 5-plate cell, and the manner in which all the positives on the one hand, and all the negatives on the other, must be connected together so as to form virtually but *two* plates, one + and the other −. This arrangement holds good whatever be the number of plates employed, which, it will be noticed, will always be *uneven.* In order that the plates may not touch (which would be fatal to their working, as it would set up a short circuit) it is necessary to keep them apart, which can be effected either by having grooves in the cells, into which the plates slide, or by placing perforated corrugated celluloid sheets between the plates. To prevent any sediment (caused by the paste falling out of the perforations during the operation of charging and discharging) from accumulating between the plates and thus short circuiting them, it is customary to place strips of celluloid at the bottom of the cell, at right angles to the plate, so that these latter clear the bottom of the cell by about ¼in. The cell is now filled up to about ½in. over the top edges of the plates with dilute sulphuric acid. This is made by mixing 4 parts *by measure* of good *brimstone* oil of vitriol, having a specific gravity of 1.840, with 21 parts *by measure* of clean rain water, or, if this is not procurable, with ordinary tap water that has been boiled and allowed to get cold. The mixture should be made in a clean glass or glazed earthenware vessel, with the precaution of pouring the acid in a fine stream into the water (not *vice versâ*), stirring at the same time with a glass rod. The mixture heats, and must be allowed to get quite cold before pouring into the cells. Directly after the above diluted acid has been poured in, the operation of charging should be commenced. For this purpose the cell is placed in *series* circuit with any generator of current electricity, such as a dynamo, a battery, &c., having an E.M.F. of 2.5 volts. Any number of accumulators can be charged at the same time, in series with one another; but bearing in mind that each single cell must be supplied with current at a pressure of 2.5 volts per cell, in order to ensure the decomposition of the acidulated water, whatever be the number of accumulator cells to be charged in series, it will be necessary to multiply that number by 2.5 to ascertain the voltage, pressure, or E.M.F. that the dynamo, &c., must give to charge the cells properly. For instance, two cells in series require an E.M.F. of 5 volts, since $2 \times 2.5 = 5$. So in like manner, if it be desired to charge (in series) fifteen cells, we should require a pressure of $15 \times 2.5 = 37.5$ volts. In charging a single cell, the positive conductor from the dynamo (or other source of current) is connected to the positive terminal or lug of the cell; while the negative conductor is connected up to the negative terminal or lug of the accumulator cell. That terminal or lug is termed *positive* or +, to which the chocolate-coloured grids are connected; the grey or lead-pasted ones being connected to the negative or − terminal. When it is desired to charge several accumulators *in series*, the + terminal of the first must be connected to the − terminal of the second, the + terminal of this to the − of the next, and so on to the end of the series, when, as before, the positive terminal of this last cell is coupled up to the positive of the source of current, while the negative of the first cell is connected up to the negative pole. The operation of charging is carried on until the liquid in the cells becomes quite milky in appearance, owing to the innumerable gas bubbles by which it is permeated. At this point, if the specific gravity be taken by means of a hydrometer, the fluid in the cells, which at the commencement marked about 1.18, will be found to have risen to about 1.21. On disconnecting such a cell from the source of current, and testing its E.M.F. by means of a *voltmeter* (for measuring the electrical pressure), it should register about 2.2 volts. It is possible to charge a considerable number of cells from a dynamo giving only 2.5 volts, provided, firstly, that the cells be arranged *in parallel*, that is to say, with all their positive lugs connected together on the one side, and all their negatives coupled up together on the other, thus forming, virtually, but one large

cell; secondly, that the said dynamo can give sufficient current to charge the cells in the required time, or, what amounts to the same thing, that sufficient time can be given for the charging operation. In our next section we propose considering the best methods for charging accumulators of the automobilists' type, the use of lamp resistances, &c., when working off electric light mains laid on in the house.

Raw Materials for Niagara's Electro-chemical Industries.

By M. M. GREEN.

THE development of hydro-electric power at Niagara Falls for electro-chemical plants brings with it sundry interesting points regarding the cost of the various raw materials which are brought there for manipulation. Among the most prominent of the materials are salt, used for making caustic soda in the Acker and Castner processes; coke, used in the graphite, carborundum, siloxicon, and carbide industries; pure glass sand, used for graphite, siloxicon, and carborundum manufacture; anthracite coal, used for making graphite; lime, for bleaching powder and carbide. The most convenient sources and the approximate cost of these materials will now be discussed in detail.

Salt.—Fine beds of rock salt, suitable for manufacturing the purest evaporated salt, by first dissolving the rock salt, then evaporating by steam heat, are found in western New York, near Warsaw, Retsof, and other towns in the Genesee Valley.

There are two well-known methods of evaporating the salt from the brine, the first by "grainers" or vats open to the air, which produce a coarse salt; the other, a vacuum process in closed vacuum pans, producing a fine grained salt, at reduced consumption of fuel. With bituminous coal of fair quality, the relative fuel required per ton of salt, by the two processes, is about as follows:

"Grainer" process, 1,300lb. per ton of salt.

Vacuum pan process, 900lb. per ton of salt.

Associated with chloride of sodium in the rock salt are small quantities of sulphate of lime and chlorides of calcium and magnesium, all of which linger as impurities in the evaporated salt. Treatment of the brine with carbonate of soda will throw down carbonates of these bases, leaving soluble salts behind. This is desirable for some electrolytic processes, but also raises the cost of the salt.

Ordinary evaporated salt may be said to contain 98½ chloride of sodium.

With coal at $2.50 per ton, the cost per ton, f.o.b. works, of salt may be said to run about as follows, including all expenses:

Grainer salt ....$2.12 per ton.
Vacuum salt .... 1.70 per ton.

The freight rate on salt per ton from the Warsaw district to Niagara Falls is 70 cents per ton for an eighty mile haul.

At Cleveland, Ohio, salt can be evaporated with coal costing not over $1.25 per ton, but the distance to Niagara Falls is 200 miles, and the freight rate is $1 per ton.

Coke.—The coke used in the electric furnace plants must be as pure as possible, as impurities require consumption of power for their volatilisation.

Ordinarily the best grade of massive Connellsville beehive coke is bought, averaging 90 per cent. fixed carbon. The selling price of Connellsville coke at the ovens for the five years ending 1903 has averaged about $2.30. Adding freight charges on the 300 mile haul to Niagara Falls would bring the price to about $4 delivered. It is unfortunate that the large amount of breeze coke, produced by the by-product coke oven plants, should be so high in ash as to debar it for electric furnace work, as it is sold cheaply to find a market.

Glass Sand.—Large quantities of the purest kind of glass sand are used at Niagara Falls in the carborundum, graphite, and siloxicon plants. As impurities are objectionable for the reason mentioned for coke, the sand is shipped great distances. At one time Niagara Falls was supplied with glass sand, averaging 99 per cent. silica, from a district near Pittsburg, Pen, 300 miles from Niagara Falls. At present the Carborundum Company is shipping sand 600 miles, from Wedron, Ill., to Niagara Falls. This deposit of sand has great natural advantages for mining cheaply, and is usually pure, testing 99½ per cent. SiO_2. This sand has been delivered in Niagara Fall for $3.50 per ton, three-quarters of this being transportation charges.

Anthracite Coal.—This material, used in egg size for making artificial graphite by the Acheson process, costs about $4 a ton at the mines in the Lehigh Valley. Its cost at Niagara Falls, including freight, fluctuates between $6 and $7 a ton. This material, being controlled by railroad interests, must be bought in the market.

Lime.—As the purest lime is required for electro-chemical industries, only certain quarries of limestone, averaging 99 per cent. $CaCO_3$ are available. Pure limestone can be quarried for 40 cents a ton, where strata are thick and well exposed, and where quarrying is carried on on a large scale. If the stone is burned with coke for fuel, 200lb. of coke per ton of stone, or about 400lb. per ton of lime, are required. If bituminous coal is used, 500lb. per ton of lime are used. The limestone for a ton of lime costs $1, at a minimum; coal from 50 to 75 cents, so that lime seldom costs less than $3 a ton, at a minimum. Four dollars a ton is a medium price, at the kiln.—*Electro-chemical Industry.*

Every aspect of the design and manufacture of electrical apparatus will be dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

The Design of Induction Motors.

By H. M. HOBART.

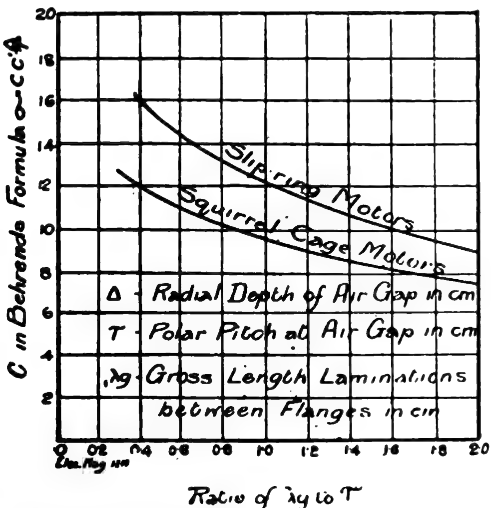
(Continued from p. 105.)

HAVING thus determined, for a preliminary estimate, the values of Δ and τ, we are in a position to estimate σ, the dispersion coefficient. σ is the most important technical constant of the induction motor. The writer, employing an extension of Behrend's method,* estimates σ by means of the following formula:

$$\sigma = CC^1 \times \frac{\Delta}{\tau}$$

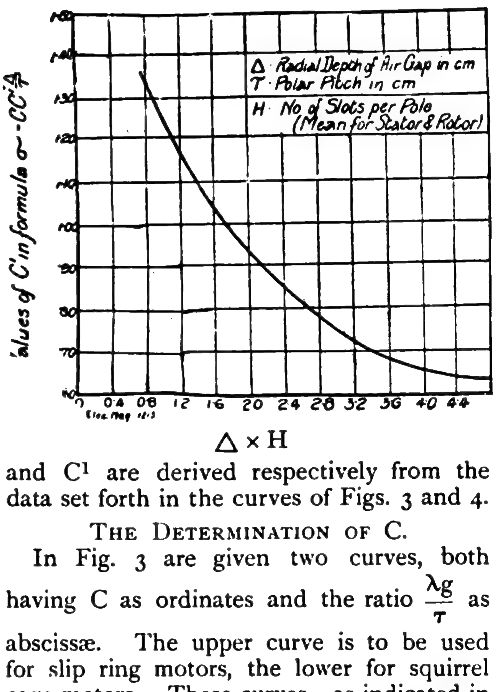
Δ and τ have already been derived. C

Curves for Determination of the Dispersion Coefficient Fig 3



The above curves should be used for open and partly closed slots. For closed, a higher value of C should be taken, the increase depending upon the thickness of the bridge.

Curves for Determination of the Dispersion Coefficient Fig 4



and C^1 are derived respectively from the data set forth in the curves of Figs. 3 and 4.

The Determination of C.

In Fig. 3 are given two curves, both having C as ordinates and the ratio $\frac{\lambda g}{\tau}$ as abscissæ. The upper curve is to be used for slip ring motors, the lower for squirrel cage motors. These curves—as indicated in the explanatory note accompanying them—must be modified in exceptional cases; for instance, if the slot is completely closed. The amount of the increase to be taken in these cases would be governed largely by the thickness of the iron bridge above the conductors.

The Determination of C^1.

In Fig. 4 values of C^1 are given as ordinates, the abscissæ being the product $\Delta\ .\ H$, where

$$H = \frac{H_1 + H_2}{2}$$

* "The Induction Motor," B. A. Behrend. New York, *Electrical World and Engineer.*

and H_1 = number of stator slots per pole,
H_2 = number of rotor slots per pole.

Having now determined C and C^1, and having previously obtained the values of $\triangle$ and τ, we obtain σ as already indicated.

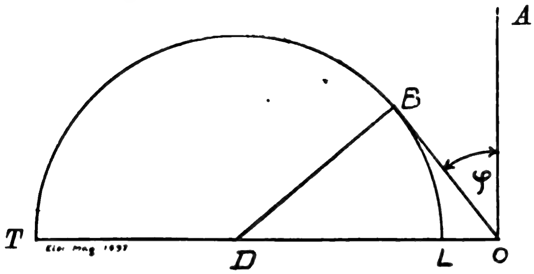


FIG. 4A.

In Fig. 4A is given the elementary circle diagram for the induction motor. In this diagram, O A is the vector along which the primary E.M.F. is laid off.

$$\sigma \text{ is equal to } \frac{O\,L}{L\,T}.$$

We have already shown how to determine σ. The determination of O L, the magnetising current, will be explained later. The value of L T, the diameter of the circle, is thus equal to the quotient of O L and σ. Having drawn the semi-circle, L B T, corresponding to the diameter, L T, we may obtain for a primary current of magnitude O B, its angle of lag, ϕ, behind the primary voltage, O A, by obtaining the point of intersection, B, of an arc drawn about O with a radius equal to the magnitude of the primary current, O B. The angle of lag, ϕ, is the angle A O B.

From σ, the maximum value of the power factor is determined from the formula

$$\cos.\ \phi = \frac{1}{1 + 2\sigma}\text{*}$$

In rough preliminary designing, at any rate, it is rarely worth while distinguishing between the maximum value of cos. ϕ and its value at full rated load, as these two values will not differ more than 1 per cent. or so from one another.

In order to carry the calculations further, we first assume a value which we will denote by γ, for the fraction which the no load current constitutes of the full load current. Fig. 5,* gives values of σ as abscissæ and of γ as ordinates. For a given breakdown actor,† γ is proportional to σ, and the curve is therefore a straight line. Such lines are shown in Fig. 5 for breakdown factors ranging from 1.5 to 5. With the values for σ given, it is not difficult to select suitable values for γ and for the breakdown factor, it being, of course, desirable to take γ as small, and the breakdown factor as large as other circumstances will permit. These are contradictory requirements and the designer must exercise his judgment and choose such values that the breakdown factor shall not be too small (preferably not

* The power factor is a maximum, *i.e.*, ϕ is a minimum when O B is tangent to the circle, *i.e.*, when B D $\perp$ O B; therefore

$$\cos.\ \phi = \frac{BD}{OD} = \frac{DL}{DL + OL} = \frac{1}{1 + \frac{OL}{DL}} = \frac{1}{1 + 2\sigma}$$

* For the method of handling γ, d, β, α, and m, as set forth below and in the curves of Figs. 5, 6, and 7, I am in great part indebted to Mr. Franklin Punga, who has developed it at my request.

† The breakdown factor is that factor by which the rated load is multiplied in order to obtain the maximum load which the motor will carry before coming to rest. The writer estimates, for comparison, a *nominal* value which is obtained by the following equation:

$$\text{Nominal breakdown factor} = \frac{\gamma}{2\sigma}$$

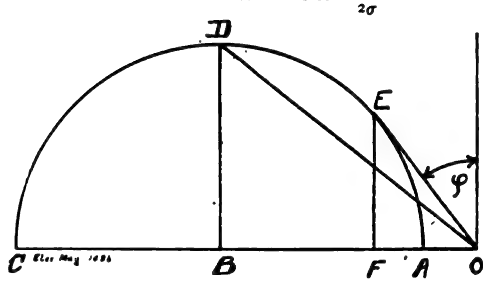


FIG. 4B.

This may be shown as follows:
Neglecting difference in efficiency at E and D (see Fig 4B), we obtain

$$\text{Breakdown factor} = \frac{DB}{EF} = \frac{\frac{1}{2}AC}{OE\ \cos.\ \phi}$$

$$\text{But AC} = \frac{AO}{\sigma}$$

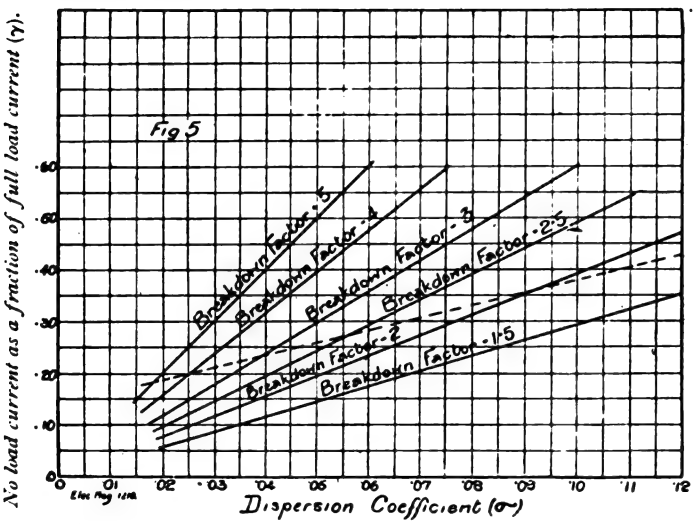
$$\therefore\ \text{Breakdown factor} = \frac{\frac{1}{2}\,\frac{AO}{\sigma}}{OE\ \cos.\ \phi}$$

Now $\frac{AO}{OE}$ is equal to

$$\frac{\text{Percentage no load current}}{100} = \gamma$$

$$\therefore\ \text{Breakdown factor} = \frac{1}{2\sigma}\,\gamma\,\frac{1}{\cos.\ \phi}$$

In reality the breakdown factor is smaller than the above value, as the efficiency decreases at the high overload. This decrease may amount to 10 per cent. or 15 per cent. As $\frac{1}{\cos.\ \phi}$ generally has a value between 1.10 and 1.15, we may say that the breakdown factor very nearly equals $\frac{\gamma}{2\sigma}$



value $\alpha m = 0.7$ should be consulted in considering the preliminary design. In this formula

$$\alpha = \eta \cos. \phi = \text{efficiency} \times \text{power factor} = \text{"apparent efficiency."}$$

As η, the efficiency, cannot be estimated at this stage of the design, an approximate value is obtained from Fig. 8.

$$m = \left(1 - \frac{\text{slot opening}}{\text{tooth pitch}}\right)$$

and is the average value for stator and rotor. m may be taken arbitrarily, according to the choice of the designer. If he prefers closed slots, m will equal unity. For partly closed slots, m = 0.9 would be a fair value, whilst for fully open stator slots and partly closed rotor slots, m varies between 0.65 and 0.8.

smaller than 2.0), and that the no load current shall not be too large, say not larger than 40 per cent of full load current. The dotted line of the figure gives a general idea of the values the author would use in normal cases.

After γ has been determined, Figs. 6 and 7 must be consulted in order to find the most important factors affecting the output of the motor. These are d, the mean density in lines per square centimètre, and β the R.M.S. ampere-turns per centimètre of periphery. Fig. 6 gives values of the product

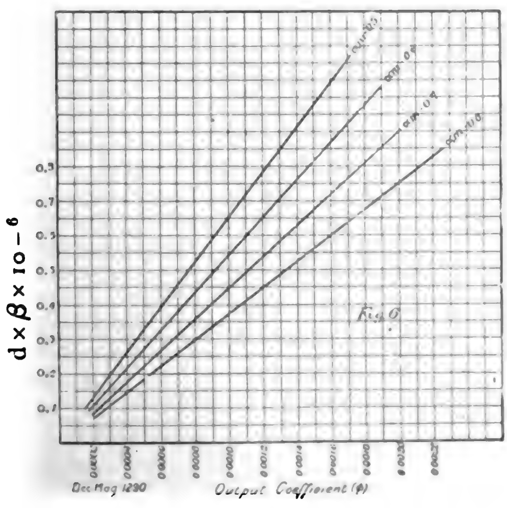
$$d \times \beta \times 10^{-6}$$

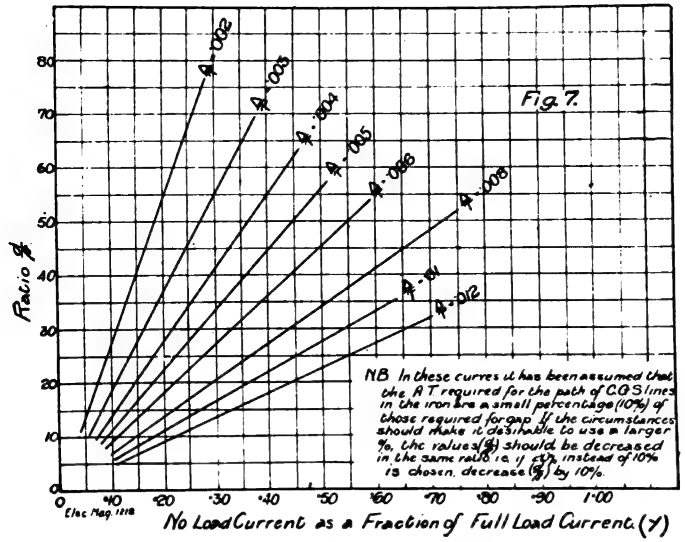
as a function of the output coefficient. Of the four straight lines given, that for the

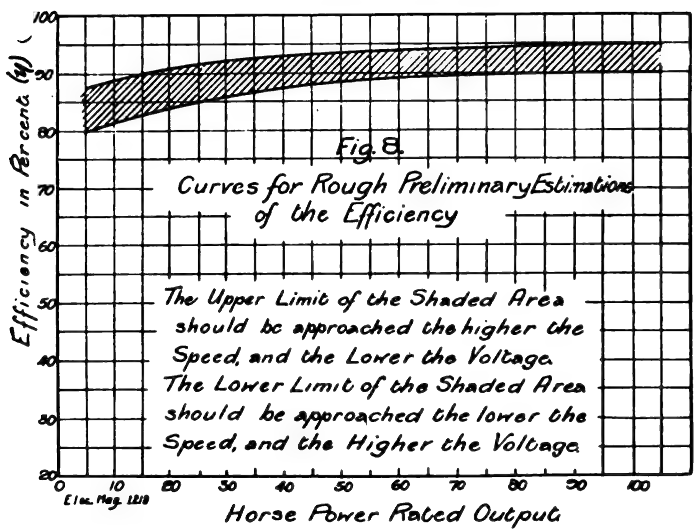
It is generally agreed that (except for low periodicities and high speeds) partly closed slots lead to the best design, as far as the performance is concerned. Wide-open slot motors will, however, be preferable in all those countries where the labour item is a considerable factor in the cost. With α m and the output coefficient given, the value $d \times \beta \times 10^{-6}$ can at once be obtained from Fig. 6.

Fig. 7 gives the ratio $\frac{d}{\beta}$ as a function of γ, for different values of $\frac{\Delta}{\tau}$. It will be remembered that $\frac{\Delta}{\tau}$ has already been used for the calculation of σ in the formula $\sigma = CC^1 \frac{\Delta}{\tau}$; and from the value of $\frac{\Delta}{\tau}$ then determined, the ratio $\frac{d}{\beta}$ may be at once obtained from Fig. 7. As soon as $d\beta$ and $\frac{d}{\beta}$ are given, the design is practically determined, for:

$$d = \sqrt{(d\beta) \times \frac{(d)}{\beta}}$$







$$\beta = \sqrt{(d\beta) \div \frac{(d)}{\beta}}$$

Flux per pole $= (m\ \tau\ \lambda_n)d$.

Total number of ampere-turns $= \beta \times$ circumference (at gap) in centimètres.

Number of turns per phase

$$= \frac{\text{Total number of R.M.S. ampere-turns}}{\text{R.M.S. current} \times \text{number of phases}}$$

(*To be concluded.*)

Our Gas Plant Supplement this month makes good reading. Don't miss it!

Commutating Poles for Direct Current Machines.

By Dr. ROBERT POHL.

For more than twenty years the endeavour of many scientific and practical men has been incessantly directed towards improving the commutation of direct current machines in order to obtain a higher specific output, and the construction of these machines has been developed to a remarkable degree. This will clearly be seen by comparing the effective weights and the cost of a modern dynamo with one of equal output built ten or even only five years ago. By careful investigations into the commutation problem, and further, by employment of effective ventilating methods, it is possible to extend the sparking limit and reduce the temperature rise so that even with considerably increased output there is, in every respect, no comparison between the quality of modern machines and those of the early days of electrical engineering. This development, however, is not yet complete, and in all probability it never will be.

Considering the present state of things, we find that for medium and larger sizes of machines, running with not too low a speed, there is scarcely any difficulty in keeping the temperature rise within reasonable limits. So the second factor—the commutation—defines the output. To reduce or suppress the sparking, a large ratio

$$\frac{\text{armature diameter,}}{\text{armature lengths,}} \quad \frac{\text{field ampere turns,}}{\text{armature amp. turns,}}$$

a large commutator with many segments, and brushes of high resistance are generally

employed. Whilst visible sparking at full load may be suppressed by these means, the sparking limit as a rule will not be very much above the full load current; thus there will always be considerable short circuit currents, which produce additional commutator losses, increase armature reaction, and possibly, after some time of running, produce sparking, if, by any other cause, the sparking limit becomes reduced. This may occur if, for instance, the commutator gets only slightly out of truth. The endeavour to find a perfect commutating device is therefore fully justified.

Numerous artificial means have been devised to improve commutation, but not one of them has attained practical importance in the design of ordinary machines (extra high speed machines excepted), and the only probable reason is that either they failed to improve the commutation sufficiently, or they did so at the expense of other

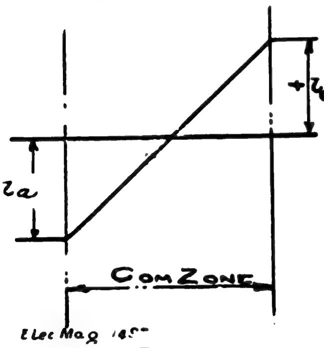


FIG. 1.

important points. The object of this article now is to show that the well-known old auxiliary poles which were invented about twenty years ago by Mather, I think, chiefly for the purpose of overcoming the armature reaction, when based upon modern commutation theory, can be brought into such a form as to produce perfect commutation, and to avoid, simultaneously, their additional drawbacks.

In the first instance, it must be defined what, theoretically, has to be considered as perfect commutation. As is well known, there is always constant current density over the whole brush face if the line of commutation is straight; that is, if the current in the short circuited coil, i_k, follows the law

1 $$i_k = i_a\left(1 - 2\frac{t}{T}\right)$$

Whereby determines

i_a = the current per armature circuit.

t = the time elapsed since the beginning of commutation of the coil under consideration.

T = The duration of commutation for one coil.

Fig. 1 shows this form, whereby the losses of commutation reach the minimum possible value and there are no additional short circuit currents. Another characteristic feature of this form of commutation is the fact that the commutator has a constant potential over the commutation zone, and that therefore, so far as electrical qualities are concerned, it does not differ from a slip ring.

This straight line has to be regarded as the ideal form of commutation. In order to obtain it there must be an E.M.F. induced in the short circuited coils which counteracts exactly, at every moment, the so-called reactance-voltage, and further, the effect of the ohmic resistance of the coil, and which is given by the equation

2 $$e = \left(L + \Sigma M\right)\frac{2i_a}{T} - i_a R_s\left(1 - 2\frac{t}{T}\right)$$

whereby represents

L, the coefficient of self-induction; ΣM the sum of coefficients of mutual induction of all simultaneously short circuited coils; and R_s the resistance of the short circuited coil.

Considering now a machine of medium size, we find the second part of the above equation, representing the drop in the coil, amounts to about .1 volt only, whereas the first part may range between 2 and 5 volts. Hence in most cases the second part can be

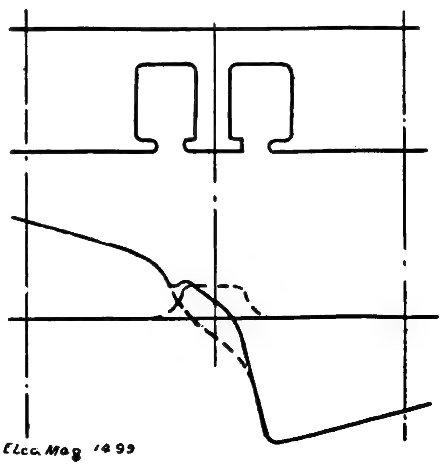


FIG.

ignored and equation 1 may be simplified by writing it

$$3 \qquad e = \left(L + \Sigma M\right)\frac{2i_a}{T}$$

The meaning of this equation may be specially noted:—as it does not contain the factor t, and as $(L + \Sigma M)$ is practically constant the E.M.F. necessary to obtain perfect commutation has to be of a certain value, and this value must be constant during the entire period of commutation.

The old commutating poles which were fixed between the main poles, differing from the latter simply in their small tangential breadth, did not fulfil this condition for perfect commutation. This will be recognised when looking into the curve of field distribution, which may be identical with the E.M.F. curve. Fig. 2 represents such an arrangement and shows the field curve which, in the commutating zone, consists of the main field produced by the main poles, and distorted by the loaded armature and of the field produced by auxiliary poles. As will be seen, the resultant field is far from being constant in the commutation zone, and the difference between the actual E.M.F. and that required for perfect commutation will produce short circuit currents, and will further create a pronounced sensitiveness of the brush position, requiring very careful adjustment of the brushes. This drawback will be more marked as, by the addition of the commutating poles, the coefficient $(L + \Sigma M)$ has been considerably increased. We may check this increase as follows:—We use for the calculation of the reactance voltage of ordinary machines the formula by P. Prenzlin,* which reads

$$4 \quad e = \frac{W \times AW_{at} \times n}{10^8 \times 30} \; \frac{\frac{p}{a}}{2 - \frac{a}{p}} \times \left\{ l_a\left(1.675\frac{N_t}{N\beta} + 3.68\log.\frac{l}{N_\beta}\right) + l_s\left(.1 + .92\log.\frac{d_a}{pN\beta}\right)\right\}.$$

In this equation, deducted for width of brushes, b = width of segment, β determines

W = Number of turns per armature coil.
AW_{at} = Total armature amp. turns.
n = Revolutions per minute.
p = ½ × number of poles.
a = ½ × number of armature circuits.
l_a = Length of armature cm.
l_s = Lengths of end connection on one side.
N_t = Depth of slot.
N_b = Width of slot.
l = Width of neutral zone on the armature circumference.

For machines with commutating poles, the actual lengths of which are equal to the armature length, the part in brackets of this equation has to be altered to

$$5 \quad \left\{ l_a\left(1.675\frac{N_t}{N_b} + 1.25\frac{b_h - N_b}{\delta_h}\right) + l_s\left(.1 + .92\log.\frac{d_a}{p\,N_b}\right)\right\}$$

whereby b_h determines the pole arc of the auxiliary poles, δ_h the air gap between the same and the armature in cm. Considering now, for example, a 250kw. dynamo for 250 volts at 500 revolutions per minute for which the required data may be

$p = a = 4 \quad W = 1 \quad AW_{at} = 40{,}000 \quad d_a = 80$
$N_t = 2.85 \quad N_b = .85 \quad l_a = 33 \quad l_s = 41 \quad l = 10$

we find the reactance voltage without auxiliary poles; e = 2.4 volts and with auxiliary poles, the pole arc of which may be $b_h = 5$ and $\delta_h = .4 = 4$mm., e = 4.4 volts. If the air gap δ_h is only 3mm., the reactance voltage increases even to e = 5.35 volts.

This very marked increase of the reactance voltage may explain the fact that commutating poles of this kind often failed to produce the desired effect sufficiently. Furthermore they increase the magnetic leakage flux by about 100 per cent. and cause a higher temperature rise of armature and field coils, by prohibiting good ventilation, and at last they require a somewhat great weight of copper for their excitation. So during twenty years their drawbacks prohibited them from being brought into practical use on a large scale.

(*To be concluded.*)

* *Electrot. Zeitschrift*, 1892, Heft. xliii-xliv.

The World's Electrical Literature Section at end of magazine contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

Continuous Current Networks, Metallic and Non-Metallic Sheathed Cables.

By L. R. LEE, Manchester.

(Continued from p. 111.)

IN considering the causes of breakdowns on electric mains other things than joint-boxes have to be considered, for instance, class of cable used, whether metallic or non-metallic sheathed, and the troughings or conduits in which the cables are laid.

If we consider the number of ways in which it is possible to install a metallic or lead sheathed cable, we shall at once see the numerous possibilities for good or evil which may be introduced to a system laid with such cable, and judging from reports from various districts these possibilities seem to be very little understood or even anticipated; but we can at all events theorise about them, and I think advance such arguments that even practice will prove to be correct.

There are at least six ways in which engineers treat the lead sheath of their cables from the point of view of electrolysis arising from stray traction currents, stray lighting currents, and from local action between dissimilar metals or metallic salts. To state these ways briefly, they are:—

1. The lead sheath continuous at all joints, either by means of bond wires or by the box, and the whole earthed at one point.

2. The lead sheath as in number one, but earthed at each joint-box.

3. The lead sheath broken at each joint, but unintentionally earthed at various places along its length, through contact with the troughing or conduits in which it is laid.

4. The lead sheath continuous at each joint and the whole insulated from earth, intentionally insulated by careful work in laying.

5. The lead sheath broken at each joint, and the whole insulated as in four. In this case the joint-boxes are probably earthed, but are insulated from the lead sheath by the ordinary wood bushes, fitting the joint-box ends.

6. The lead sheath continuous at joints; the whole insulated and then earthed at two points, the generating end and the far end.

All these six methods have their adherents, while it is possible that there are others who have no method, or having one do not know which.

The first method is the one most probably used, but generally no care is taken to insulate the lead while laying the cable, so that it may be insulated or not, and if it be insulated except at the one earthing point, no harm should, theoretically, come to the lead through outside stray currents, as the lead does not form part of an electric circuit, so that currents cannot travel by it, but the earthing at this one point serves no useful purpose, as if a fault develops on the cable, the lead sheath is practically certain to be welted away all around the fault, thereby cutting it into two portions, the far part charged at a potential which will break it down elsewhere, and the near part still earthed. If the lead be earthed unintentionally at other points, then it becomes

part of an electric circuit, or circuits, and is bound sooner or later to be destroyed, owing to differences of potential and to stray lighting currents, which, being generally from the negative side, make the earthed sheath positive and hence destroy it by making it one electrode of a simple primary cell. On the other hand, it may be said that nowadays, cable purchased from reliable firms does not break down, so that if the cable is carefully laid and insulated, before being earthed at the one point, it is probable that nothing untoward will happen.

The second method often obtains, and is brought about by laying the cable in pot or wood troughs, and by wiping or otherwise connecting the lead to each box. Here, each box becomes an earth plate and each one is of a different potential to the next one, either being positive or negative to it, and it will be found that the lead will disappear, in time, at its junction with the iron joint-box, it being, of the two, the metal most easy of destruction. In cases of this kind, to put the matter right all that is required is to dig a hole round each joint-box and surround it with bitumen, thus insulating the lead in its entirety, but after having done so, should a fault occur on the cable, *per se* the lead sheath will be broken down at many places, owing to low insulation at cable bridges.

The third method was in use many years ago, and has given little or no trouble, in fact there is no reason why it should give trouble. If a fault occurs between any two joint-boxes, it would simply burn out the lead on its own length and would not affect any other portion of the same main. The lead would also not be affected by stray currents, as each separate piece of lead, although it may be earthed, cannot form part of a circuit; but it will be subject to local leakages from lighting circuits if the earth contacts are good. If the cable were laid in wood troughing and entirely surrounded by bitumen, no trouble at all should result.

The fourth method gives entire freedom from all troubles of electrolysis, but in the event of the cable itself breaking down, the lead sheath becomes punctured along its entire length at all points of low resistance. As the lead, being insulated, cannot become part of a circuit, it can carry no stray currents. (*To be concluded.*)

Steam Economy Suggestions.

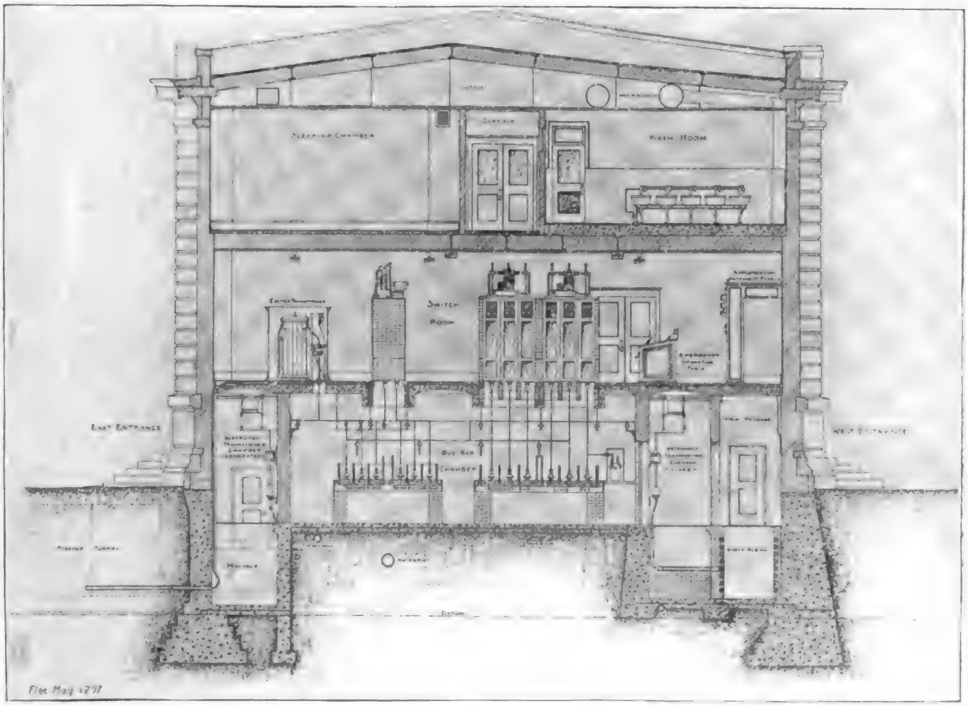
Canada may be justly considered the land of hydro-electric developments, but that is no reason for disregarding any advice her engineers may tender from the field of steam usage. When the Canadian Electrical Association met this year steam economies was a subject down for discussion, and the paper read by Mr. W. McKay contains many points of practical interest which may well become axioms of the boiler house. Mr. McKay at the outset of his remarks emphasises the influence of plant extension on steam economies, how a much lower efficiency is obtained when a station is built up piecemeal than when previously designed and erected for a given output. From boiler design to steam piping the entire gamut of efficient steam raising is run, and the first mentioned comes in for some pointed criticism:

"The length and area of grate that can be conveniently fired or kept evenly covered with coal is, perhaps, the limiting feature if hand-firing is to be used. Working from this rule, a grate should not be over 7ft. long or more than 5ft. wide, which would give 35sq. ft. of grate surface. The quantity of coal that may be burned on such a grate varies widely with the kind of fuel and strength of draught. Using bituminous slack coal of fair quality, with good natural draught or moderate induced draught, it should be possible to burn 25lb. of coal per square foot of grate per hour, or 875lb. of coal per hour; and if this coal will evaporate, say, 8lb. of water per pound of coal, the boiler, if constructed with heating surface in proper proportion, would evaporate 7,000lb. of water per hour, which would be equal to a little over 200 standard boiler-horse-power. In order to give good economy, the boiler should have from 2,000 to 2,400sq. ft. of heating surface to evaporate this quantity of steam economically. The return tubular boiler, on account of the amount of tube surface in proportion to the direct surface exposed to the fire, should have not less than 12sq. ft. per horse-power; the water-tube type from 10 to 11, and the internally fired type, which has a larger amount of direct heating surface in the furnace and tubes than either of the others, should have 9 to 10. If the grate surface is larger than that described, probably the grate will not be

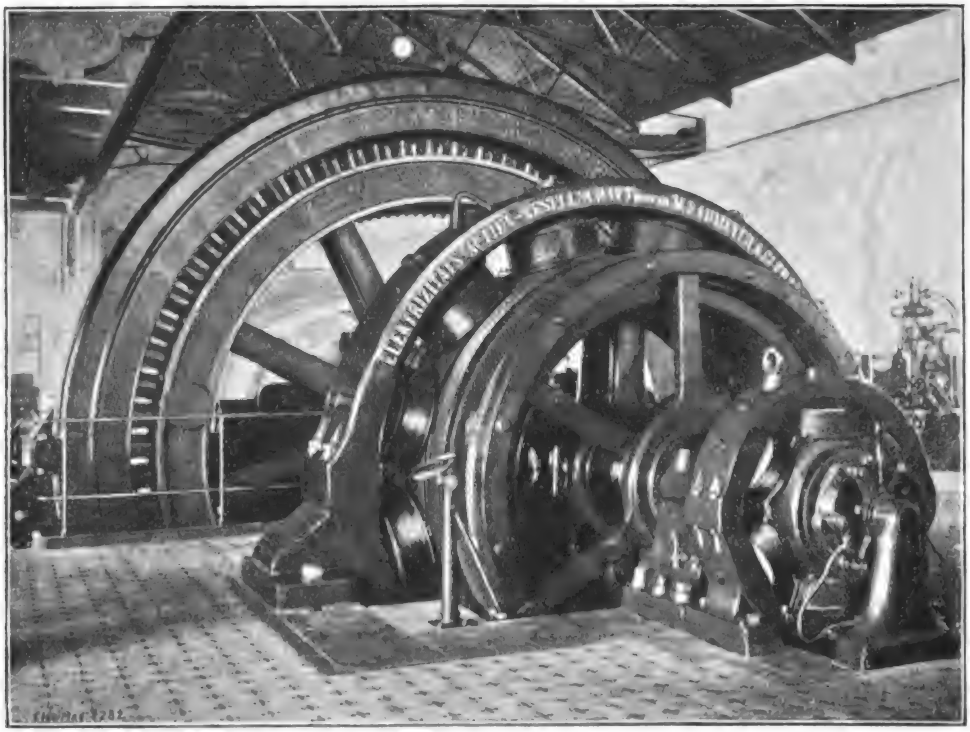
evenly covered with coal, or the fire will be dead in spots, so that too much cold air will pass through."

Mr. McKay then condemns the practice of increasing the grate surface in too great a proportion to the heating surface, to meet the demands on the plant. He also severely criticises the tendency to high capital expenditure on engines and condensers, with certain economies in view, whereas losses out of all proportion were traceable to the boilers and firing. He is emphatic in his support of large boilers: as air leakage is reduced better combustion results and radiation losses are lessened. Spare boilers should always be of the same size as the plant they supplement. In the matter of steam pressure the higher this the better, and 150lb. is fixed as the minimum limit. In his comparison of boiler types the author is worth quoting in full:

"Experience shows that any of the standard types, horizontal return tubular, water-tube, or internally fired, if designed with proper proportions of heating and grate surface, give about the same evaporation per pound of coal, provided they are in good condition and clean both on the fire and water surfaces. While the externally fired boilers, either of the return tubular or water-tube type, are said to have some advantage in combustion, on account of the heat of the brick furnace, they are subject to losses which are more serious, in the way of air leakage and radiation. Tests made at the Ohio State University, by Professor Hitchcock, show that the brick-setting of boilers continues to absorb heat up to 72 hours after being started, and that the average waste of heat in brick furnaces is about $8\frac{1}{2}$ per cent. As the members of this association well know, the repairs and cost of keeping up brick furnaces is considerable, and as a result of deterioration there is more or less air leakage through the brickwork going on constantly. In this respect, the internally fired boiler has a great advantage over return tubular or water-tube boilers with



MAIN SWITCHROOM OF FISK STREET STATION, CHICAGO EDISON CO.
This is a separate building, and contains controlling apparatus for 5,500kw. Curtis Turbo-Generators. Notice the sleeping apartments for the switchroom staff.
Illustrations of prominent Central Stations will be made a feature of this section in future.



WIESBADEN ELECTRICITY WORKS.

An 1,800h.p. steam engine is coupled to two generators; an 800kw. alternator and a d.c. dynamo of the same output. An exciter is also on the same shaft. This combination for tramway and lighting enables the engine to be run near full load with greater economy than two separate sets.

brick furnaces, as it will be just as efficient after continued use as when first started."

Water purifying plants are frequently condemned without a hearing or regarded as costly expedients, but there is no gainsaying the author's unqualified approval of such apparatus being installed. He says:

"Nothing but pure water should be used for making steam, and the practice of making the boiler do duty as a water purifier as well as a steam generator cannot be too strongly condemned. If the owners of steam plants could be made to realise that a very small deposit of soot on the outside and scale on the inside means a loss of from 10 to 20 per cent. of the total fuel consumption, costing, perhaps, thousands of dollars per year, they would be convinced that it would be much cheaper to spend money in purifying apparatus, so that the scale or sediment will be removed before the water is fed to the boiler."

Feed water heaters are a source of economy in small plants, but should be replaced by an economiser for larger installations. The latter is regarded as too costly initially and in upkeep for small units. Closed heaters are recommended, though the open type in proper hands will do duty as a purifier.

Stations are often confronted with the problem of steam pressure during light loads, and here again Mr. McKay gives sound advice:

"From my experience, I do not believe it pays to reduce the pressure on the boiler, excepting in very extreme cases, but if it can be done by throttling before the steam reached the cylinder of the engine, it would be an advantage, because this retains the heat units due to the higher pressure in the steam, and the throttling has a slight superheating effect. As a matter of fact, tests made by Willans and Robinson, of England, go to show that for light loads and high pressure, a throttling engine may do even better than automatic cut-off. The ideal arrangement is to throttle the steam for light loads up to say near

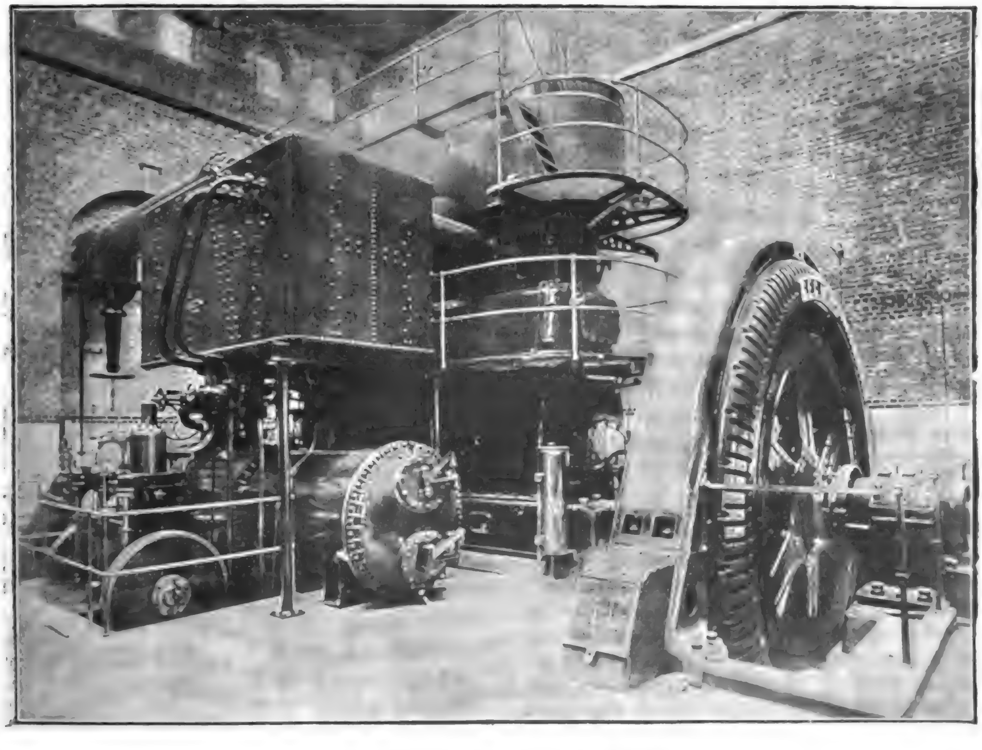
quarter cut-off, and after that, for heavier loads, allow the variable cut-off to come into play. This practice has been carried into effect by the design of Mr. E. J. Armstrong, in which he arranges the shaft governor so that there is negative lead up to nearly one-quarter cut-off, after which the lead becomes positive, and this has the effect of throttling the steam for the earlier loads and undoubtedly gives better economy, in addition to making the engine run more quietly."

Summing up, the author thus concludes:

"In general, it may be said that the principal cause for loss in steam plants is the use of engines which are overloaded or unsuited to the conditions of work, undersized, or badly arranged steam and exhaust pipes, and the imperfect condition and poor operation of the boilers. In many plants, exhaust steam, which might be utilised for heating, is wasted, and in others, where the exhaust steam is utilised for heating, power is wasted by excessive back pressure. The most economical use that exhaust steam can be put to is for heating, because all the heat units are made use of, but it should be done without back pressure on the engine, by means of a vacuum system to draw the steam and water through the heated pipes, otherwise there will be a loss both of fuel and power, due to the engine working under imperfect conditions.

Protection from Current Thefts.

WHATEVER our reputation may be for harbouring aliens of doubtful character with propensities for "picking and stealing," we are not troubled much in this country with thieves of electric current. Judging by the answers in the question-box of the National Electric Light Association to the query printed below, certain American central stations are in need of a detective in the cellar of some consumers. The wrinkles suggested are worth putting on



DUBLIN CORPORATION ELECTRICITY WORKS.

Extension unit of 1,500kw. Bellis-G. E. C. In same station are Oerlikon alternators and slow speed engines. The 1,000kw. sets of these have thirty-six coils per phase and the revolving element weighs 44 tons. In the new set depicted above these figures are reduced to 30 and 28 respectively.

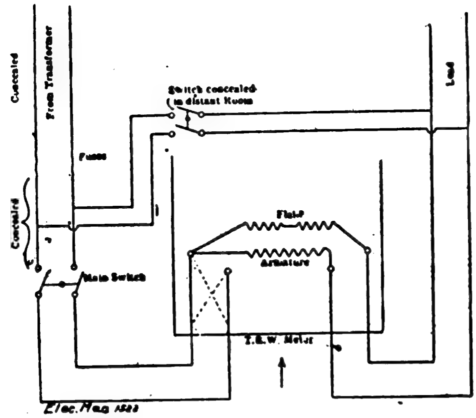


DIAGRAM SHOWING CONCEALED WIRING CONNECTIONS TO PREVENT CURRENT THEFT.

record, and our readers may have occasion to put some of them into practice:

What effective means, if any, have been found to make it impossible for a customer to beat a recording wattmeter, or what special precautions can be taken by an electric light company to detect the same?

ANSWERS.

W. H. Greenslit: The accompanying diagram (see above) will show a case I once found and its remedy. The customer had concealed wiring in the house and only main-line cut-out and meter loops were exposed. This was remedied by crossing the wires in the meter according to the dotted lines and sealing the meter; consequently, when he had closed both concealed and main-line switch it would blow a fuse. Even this left a chance for him to beat the meter, yet in a quiet way it informed him that we were familiar with it.

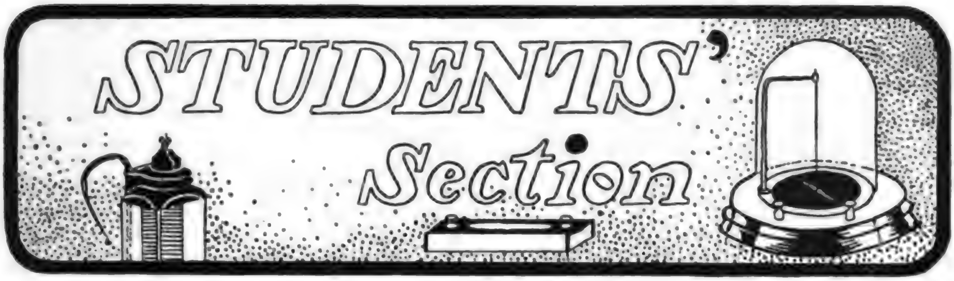
Elberd D. Kelley, Hillsboro Gas and Electric Company, Hillsboro, Texas: Keep your meters sealed, and in wiring do not allow the main cut-out and circuit blocks to be put too close together; in my system of wiring, one is in front and the other behind the meter. A meter man should study character; if thing are suspicious, go at unusual hours for inspection or reading.

G. R. Radley: Put a strongly made wooden box, with inside screwed hinges, close to the service end. Run service wires directly into the box, or use iron pipe if not possible to locate the box there. Have the neutral run through solid—without fuse—and locate closely rated enclosed fuses in box after meter. This arrangement will prevent the customer from purposely blowing one service fuse on the side from which the meter takes its potential and then burning half (or by bridging over all) his lights without any registration. The box must be three inches larger than the meter to prevent external magnets being used to create strong stray field. The inside of the box should be painted black, so that small drill holes will be conspicuous when inspecting the meter. Use a good Yale padlock and obliterate the maker's key code, which is stamped on the side. Keep track of the customer's consumption and if it does not check out examine the meter at night.

W. W. Titzell: The most effective means to prevent the customer beating the meter are: First, an all glass instead of a metal cover, as the latter can be drilled and a piece of wire inserted to stop the disc; second, connections of both legs of circuit through the meter, so that cutting one leg will prevent the flow of current; third, enclose the meter and connections in a locked box inaccessible to anyone except the holder of the key; fourth, have the inspector examine carefully and frequently all connections and lines from the main cut-out to prevent bridging.

"A.' H. A.," New York Edison Company: We do not know of an effective means to make it impossible for a customer to beat a recording wattmeter. Even with meters of the sealed type with internal connections for the service and house leads an occasional case may be found where there has been a deliberate attempt at theft of current. The precautions should be a very careful system of examination by inspectors, meter readers, and meter testers, examination of seal of the meter, wiring and service conditions.

"E. A. N.," New York Edison Company: The question of proper protection to service and meter appliances is one that will ever be important to lighting companies. There is no system of surveillance that can be relied upon to detect all cases of interference. If a customer's account decreases suddenly the bookkeeper should advise an investigation, likewise, all inspectors, meter readers, meter testers—in fact, all persons connected with the lighting company and visiting customers' premises—should instantly note any irregularity and report it to the office. The value of a good detective force will be appreciated here, for it should be its duty to follow up the case, detect, and if necessary secure the conviction of the guilty parties.



Students should refer to the World's Electrical Literature Section at end of magazine for classified list of articles of special interest to them.

Polyphase Motors on Single Phase Circuits.

By G. H. GARCELON.

OCCASIONALLY it is desirable to operate a polyphase induction motor on a single phase circuit. Its characteristics, however, will not be as good as before, and some special device will have to be employed to make it self-starting. The definite relations given below are applicable only to motors having cage-wound secondaries. Motors with coil-wound secondaries can also be operated single phase, but their performance will depend to a large extent upon the secondary resistance, and in general will not be so good as that of motors with cage-wound secondaries.

A motor operating in this manner will, with the same slip and temperature rise, carry approximately 70 per cent. of its normal polyphase load. The pull-out or maximum running torque will be decreased one-half or one-third, depending upon the slip, the motor having the smaller slip giving the greater pull-out. The efficiency and power factor will in general be highest at 70 per cent. of the normal polyphase load, but will be from 6 to 12 per cent. lower than originally. Operating as a single phase motor, the polyphase motor will not develop any starting torque. It is not necessary, however, to bring the motor up to more than one-fifth normal speed in order to make it pick up when the load is very light. The motor may, therefore, be started by a vigorous pull on the belt.

If it is desirable to make the motor self-starting, it can be accomplished by using resistance, inductance, or capacity in one or more of its phases. In this manner the current in the different circuits is thrown out of phase, or split, which will give a weak rotating field sufficient to produce a small torque. There will be a large loss in the resistance or whatever device is used to split the phase. Therefore, it is generally cut out after the motor is up to speed.

Fig. 1 shows a method of connecting a two phase motor and resistance through a double-throw switch. The curves, Fig. 2, show the results of a test on a two phase motor operated in this way. These show that the starting torque depends on the value of the resistance in series with the starting phase. It will also be noted that the torque increases as the resistance is decreased until the maximum is reached, when, if the resistance is still further decreased, the torque falls off very rapidly. This maximum point is explained as follows: The larger the value of the resistance, the greater the phase difference in the two circuits, and the more nearly is the condition of a two phase circuit approached. On the other hand, the larger the value of the

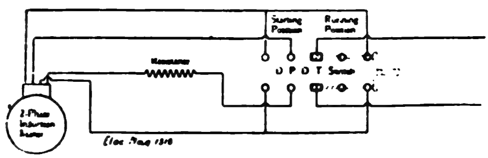


FIG. 1.

E

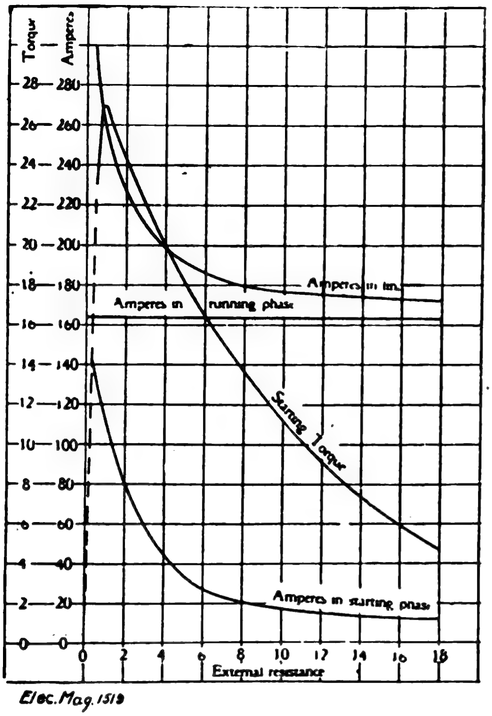


Fig. 2.

resistance, the smaller the current in that winding. The torque depends both on the magnitude of the currents and their phase relation, and the maximum torque occurs when the resultant effect of the two is a maximum.

Fig. 3 shows the phase relation and the relative values of the current in each circuit for two different values of the external resistance. OE represents the line voltage. This consists of two components at right angles, the ohmic drop and the inductive drop. Since the same voltage is applied to each circuit, OE will be the resultant of the ohmic and inductive drops of each. Ir and Ix are the ohmic and inductive drops respectively in the running circuit, the inductive element being much the larger. The current in phase with Ir is represented by I and lags behind E by an angle ϕ. When there are four ohms in series with the starting phase the current in that circuit is I_1, and the drops are I_1r_1 and I_1x_1. The current in the starting phase is here ahead of that in the running phase by an angle ϕ_1. This gives a good split, but the current I_1 is small, therefore the torque is small. The total current drawn from the line is the resultant of O I and O I_1. With one ohm in series, which gives approximately the maximum torque, the current is I_2, the drops are I_2r_2 and I_2x_2, and phase difference is ϕ_2. The line current will be the resultant of I and I_2. For a given motor the value of the resistance to be used is best determined by a simple test. Place a non-inductive resistance (water rheostat) in series with one phase and adjust it until a desirable torque is obtained. Then measure the volts across the rheostat and the current in the starting circuit. The volts divided by amperes will give the ohms required.

Fig. 4 shows a three phase motor connected for operation on a single phase circuit. In this case both inductance and resistance are used for starting. The current in the different circuits is split as before, but here there are three currents each of which is out of phase with the other two. This motor could be started with either the resist ance or the inductance alone. Resistance will give better results than inductance because the motor winding itself is almost entirely inductive, as can be seen from the curves of Fig. 2, and therefore the current in the starting phase cannot be made to lag very far behind that in the running phase. Condensers are sometimes used. They are, however, expensive and none too reliable. A condenser will, of course, give a much larger phase difference than resistance, but in order to be of sufficient capacity to carry an appreciable current it must be quite bulky. If allowed to remain in circuit while the motor is running it will raise the efficiency some and the power factor very materially. In general the most satisfactory

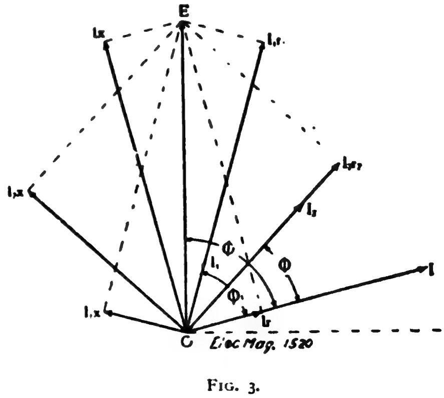


Fig. 3.

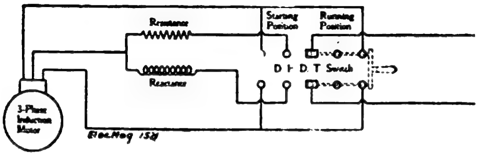


FIG. 4.

method of splitting the phase will be found to lie in the use of a simple non-inductive resistance which may readily be improvised. —*Electric Journal.*

Power Factor in Induction Motors.

By A. A. AVERRETT.

THE question whether three phase or two phase induction motors have the higher power factor, other features being equal, has often been discussed. The following considerations show that a three-phase motor always has the advantage of a higher power factor than a two phase motor having an equally good arrangement of copper and the same maximum output and efficiency.

Three phase and two phase motors are actually wound six phase and four phase (60° and 90° windings) respectively. The operating conditions for induction motors are somewhat similar to those for six phase and four phase rotary converters, in which the six phase winding gives better results than the four phase winding.

The reason for the superiority of the three phase, 60° winding lies in the fact that the ratio of effective turns to actual turns is as the chord to the arc. The ratio is $\frac{3}{\pi}$ in 60° windings, while in two phase (90°) windings the ratio is $\frac{2\sqrt{2}}{\pi}$. In other words, the 60° winding has 95.6 per cent. of the actual turns effective, while the 90° winding has only 90 per cent. of the turns effective. Fig. 1 graphically presents this advantage of the three phase over the two phase winding, by showing how the length of the chord approaches the length of the arc more nearly in the chord which subtends an angle of 60° than in the chord which subtends an angle of 90°.

A representative General Electric three-phase motor having a power factor of .90 at full load and .83 at half load will have about .32 magnetising current, .165 reactance, and a stationary impedance current of about 5.75 times full load current. The same motor if wound two phase will have .36 magnetising current and the same reactance (.165) at full load, which will give a power factor of .89; while the half load power factor will be .80.

The following table gives the values of power factor at full load and half load, and of per cent. magnetising current and per cent. reactance at full load, for "moderate-speed" and "slow-speed" three phase and two phase motors. In computing these results, the energy losses, which would affect the results but slightly, have been neglected. The power factor at full load may be found by the approximate graphical method shown in the example, Fig. 2, knowing the per cent. magnetising current and per cent. reactance.

Type of Motor.		% Power Factor.	% Mag. Current.	% Reactance.
3 Phase Mod. Speed	Full Load	90	32	16.5
	Half Load	83		
2 Phase Mod. Speed	Full Load	89	36	16.5
	Half Load	80		
3 Phase Slow Speed	Full Load	84	45	20
	Half Load	69		
2 Phase Slow Speed	Full Load	82	50.5	20
	Half Load	65		

While these results are approximate, the same degree of approximation is obtained in each case, so that a comparison of the results gives a fair idea of the relative values of the two types of motor. The power factors and magnetising currents in the above table show the superiority of the three phase 60° winding over the two phase 90° winding. It will be noted that the advantage of the three phase over the two phase winding is somewhat greater in the slow-speed than in the moderate-speed motor.

The above considerations show that two phase motors have inherently a lower factor than three phase motors. The data fairly represent good modern induction motors.

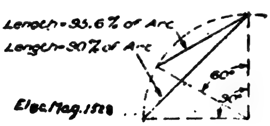


FIG. 1.

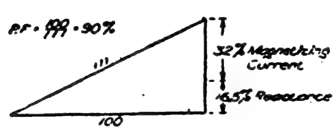


FIG. 2.

It is possible to make as favourable a power factor showing for the two phase as for the three phase winding by the use of an excessive amount of material and at the expense of efficiency.—*Electrical World.*

How to Make an Electric Buckboard.

By J. C. BROCKSMITH.

(Continued from p. 120.)

FIG. 7 shows the detail of front and rear axle bearing castings. Cast iron will answer for these, although malleable iron or steel would be better. The rear axle cases are bored and threaded to take the steel ball cones, and the front axle fittings are simply bored 1in. and clamped in position on the tube by means of a couple of $\frac{5}{16}$in. cap screws. If tolerably smooth these castings need not be finished on top, where they are screwed to the frame. Four holes are drilled and tapped $\frac{5}{16}$in. for this purpose.

Fig. 8 gives the details of a number of small parts all relating to the steering gear. Their use and location will be seen from an inspection of the general drawings of the machine. These are all made of phosphor bronze, and one is required of each except in the case of the small jaw casting, of which eight are wanted. There need not be any finish allowed on any of these castings except where, as indicated on the drawing, they are to fit the inside of tubing.

Fig. 9 shows the hub caps, which are made of the same aluminum alloy as the differential gear case and are finished bright. The steel caps for driving the rear hubs have already been described in connection with the rear axle.

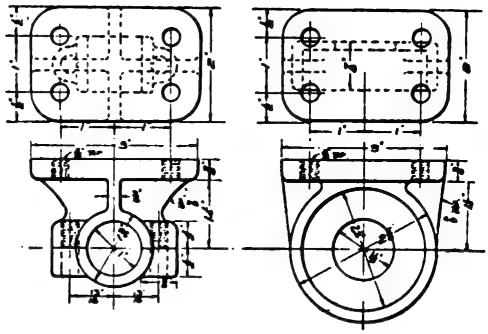


FIG. 7. AXLE BEARINGS.

The following is a list of the steel stock required to construct the running gear:

No. wanted.	Material.	Wanted for.
2 pcs.	83.2″ × 2 × ⅛″ angle	Frame.
1 pc.	50″ × 1¼″ nickel steel	Rear axle.
2 pcs.	4⅜″ × ¾″ tool steel	Front axle ends.
2 pcs.	15½″ × ½″ 20G. tubing	Steering gear.
1 pc.	30″ × ½″ 20G. tubing	Steering gear.
1 pc.	28½″ × ⅞″ 16G. tubing	Steering upright.
1 pc.	14½″ × ½″ 20G. tubing	Controller sleeve.
1 pc.	9⅜″ × ⅞″ 16G. tubing	Steering handle
1 pc.	33½″ × 1″ 14G. tubing	Front axle.
1 pc.	43½″ × ½″ 20G.	Brake rod.
2 pcs.	24¾″ × 1¼″ 20G. tubing	Motor supports.

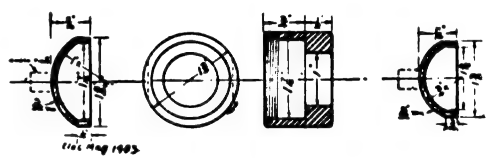


FIG. 9. HUB CAPS.

The Motor.

In previous issues complete information and drawings were given for the running gear. It is the purpose of the present and the following articles to describe the motor with which to drive the buckboard.

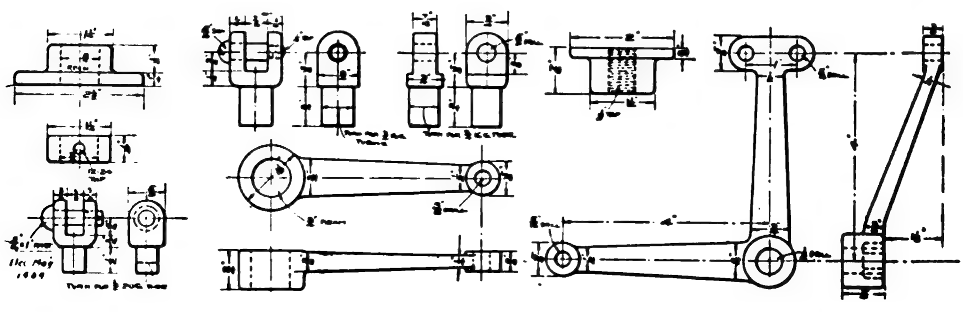


FIG. 8. STEERING GEAR PARTS.

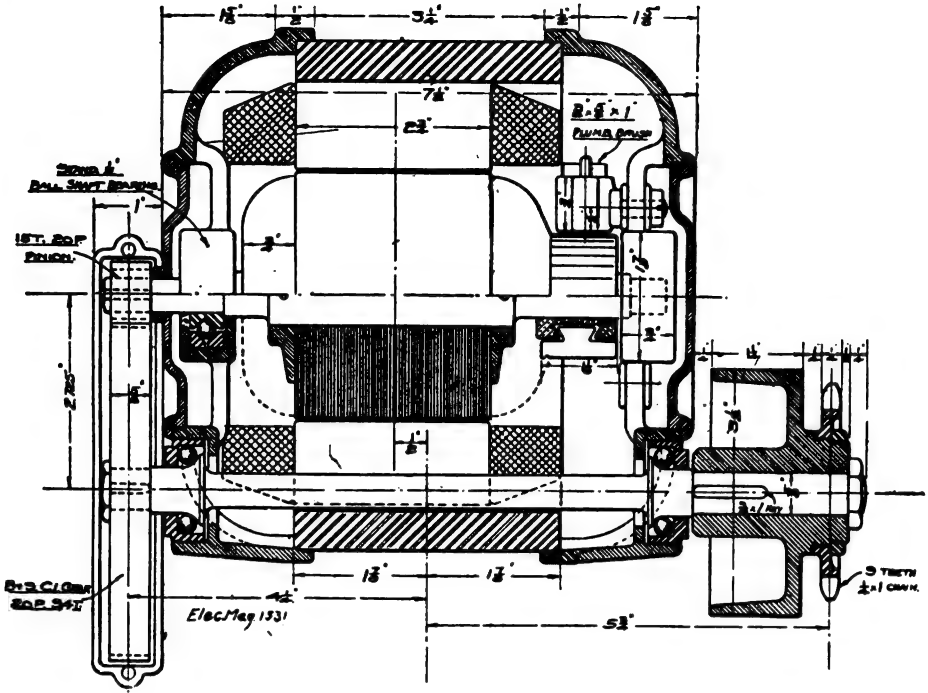


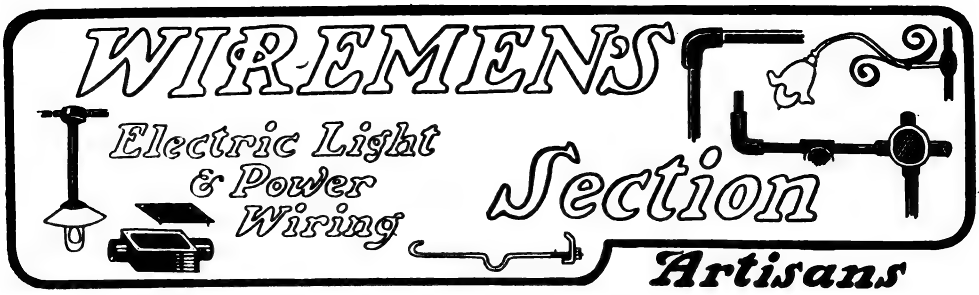
FIG. 10. VERTICAL SECTION THROUGH COMPLETE MOTOR.

The motor is a four-pole machine having a circular yoke of soft cast steel in one piece with the poles. It is provided with cover plates of aluminum alloy, which completely encase the working parts. All the motor bearings are of the steel ball type in order to reduce friction and wear to a minimum. The winding is of the series type for 80 volts and the speed under full load and voltage is 2,800 to 3,000 revolutions per minute. The maximum brake horse-power is about $1\frac{1}{2}$.

Fig. 10 is a vertical section of the complete motor, which shows the working parts of the motor in their proper position. This view brings out the construction of the bearings, commutator, brush holders, and also the reduction gearing upon the sprocket shaft. It will be noted that the field cores are set somewhat off the centre of the yoke, which allows for the space taken up by the commutator, and permits of the use of cover plates, which are alike, and therefore require only one pattern. The large central opening in the shell is bored and threaded to receive caps, which when screwed on completely encase the motor. By removing the cap at the commutator end the brushes and commutator may be inspected without disturbing any of the other parts. The size of brushes used is $\frac{3}{8} \times \frac{5}{8} \times 1$in. plumbago.

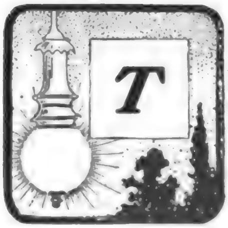
The counter-shaft, which carries a sprocket on one end for the chain drive, passes through the motor between the two lower field coils and has a 94-tooth, 20-pitch B. and S. gear keyed on the opposite end; this meshes with a 15-tooth, 20-pitch pinion made of tool steel and hardened in oil. This makes the distance between centres 2.725in.—*American Electrician.*

(To be continued.)



Wiremen and Artisans should refer to the World's Electrical Literature Section for classified list of articles on subjects of importance to themselves.

Wiring Scamps.



THE wiring of buildings, and especially of private houses, is one of those unfortunate things in electrical engineering which can be done very badly and escape notice. The wiring scamp is the product of a too keen competition in an already overcrowded field. He has occasioned a state of affairs which is now a standing disgrace to this branch of the industry, but which continues, nevertheless, in the most aggravated forms. We were recently afforded an opportunity of inspecting the conduit work in a private house, then nearing completion, in a university city—a house upon which money had been freely lavished for its equipment in the best possible manner, and which the future occupant desired should be made as complete as capital, brains, and labour could make it. The wiring lapsed into the architect's hands, and, with that *savoir faire* common to his kind, he gave the contract to the lowest bidder, who essayed to wire the place, using steel conduit. Our preliminary inspection revealed the tubing without screwed joints, and no attempt to keep the barrel continuous or earth it anywhere. Where the barrel fell short of the switch-blocks and ceiling patresses, the wire was left unprotected either from brick or plaster. Under the floor of the lower rooms hot-water pipes were laid to supply radiators, and at one point the tubing crossing the joists was sharply bent over a joint in the water-pipe. This bend had a suspiciously angular look, and, on running the finger along its outer diameter, it was found that the tube had cracked sufficiently to admit the nail; and this close to a water-pipe union which might leak any time! Equally neglected were the bell-wires, which in some cases were carefully threaded in lead pipes, and in others left exposed to the attacks of epicurean vermin. In such cases the prospective owner of good property is at the mercy of his agents and avowedly professional advisers, who are small-minded enough to prey upon his implicit confidence in their integrity. Even more scandalous was the condition of things presented by the work of so-called electrical engineers in houses renting at about £45-£60 per annum. Not twenty miles from the Metropolis, we casually entered some property, on the scaffolding of which a notice foreshadowed the deeds of the electrical engineer within. We were not a little astonished to find that this contractor had mixed ideas, which extended to the protection he gave the wiring of the various rooms. He was actually running steel conduit and wood casing together. The casing was nailed to the joists and the tubing did service down the walls, doubtless to act as an effectual drainpipe for damp and sweat from the mortar and plaster. Such consideration for the occupier, who might be flooded out but for these emergency aqueducts! If the wire protection was bad, the wiring was infinitely worse. It was nothing short of criminal, and for 200 volts! Frequent gaps between casing and piping were conveniently bridged with the exposed wire left to become the *hors d'œuvres* of some future rodents' banquet, while the raw edge of the barrel was unsparingly applied to the

insulation where suitable opportunity presented. The contractor must be a poor creature of circumstances to call work of this kind electric lighting. The conglomeration of casing and conduit was teeming with "incidents" in the installation which would turn the hair of a respectable electrician grey. At one point, for instance, the casing was deliberately split in the groove, and through this crack the wire was forced and passed into the the pipe below. For the sake of the future of electric lighting we pray to be delivered from these creatures, who bring calumny and reproach on the industry, either by their utter incompetence to do work properly or their complete disregard of the obligations imposed by an honourable compact. It is injustice enough that the industry should harbour these contract-pirates, but the time for protection from their insidious encroachments has certainly arrived when work of the character we refer to above is being done. It is useless to frame wiring rules unless means are taken to enforce them where rascality is known to be at large. We shall welcome any movement giving power to central station engineers to strictly inspect wiring installations, and rigorously expose all attempts at that scamping which imperils not only the confiding householder, but also the entire electrical industry. Offenders should not merely be warned, but hounded out once and for all.

Mercury Vapour Converters.

In the course of their travels wiremen will have encountered the mercury vapour lamp in one form or another. They may not, however, be familiar with a special adaptation of its principle to the rectification of alternating into continuous currents. There is a wide field for this form of con-

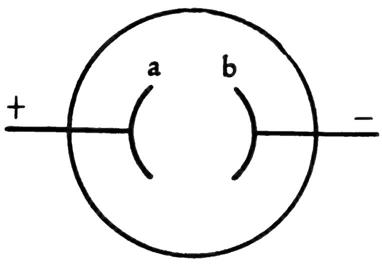


Fig. 1.

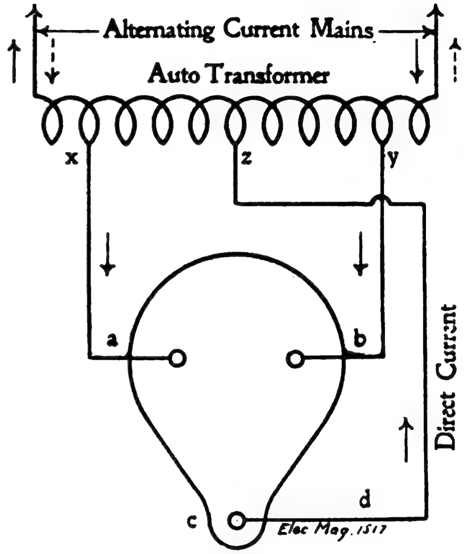


Fig. 2.

verter as it is suitable for battery charging and the operation of continuous current motors. We abstract below a clear description of the apparatus which, with the diagrams, will make its action quite clear. The source of our information is the *Electric Journal* of Pittsburg.

The operation is as follows:

Let Fig. 1 represent a vacuum tube or globe filled with mercury vapour and provided with two electrodes. To establish a current across this gap it is necessary to raise the potential to a very high value, perhaps 25,000 volts, but after current is once established 10 to 14 volts is sufficient to maintain it. This high starting potential is practically all due to a peculiar resistance offered between the mercury vapour and the surface of the negative electrode. As soon as the current is established, this particular potential drops to about 4 volts. The total running potential is made up about as follows: 4 volts between the positive electrode and the mercury vapour, 2 to 6 volts through the mercury vapour, and 4 volts between the mercury vapour and the negative electrode. The potential at the positive electrode and that through the mercury vapour are approximately the same for both starting and running.

If once the current flow ceases even for an instant the negative electrode resistance is established and the high starting potential must again be applied. It is one of the

remarkable characteristics of this apparatus that, though the period of zero current is but momentary, it is quite sufficient for the high resistance of the negative electrode to establish itself. It has been estimated that this can occur in one-millionth part of a second.

If now some means of breaking down this high potential is permanently applied to one electrode, as *b*, Fig. 1, and alternating current is applied, it is evident that the current will flow through the apparatus only in one direction, from *a* to *b*, since there will be now no electrode resistance at *b*, whether *b* is positive or negative, but there will be resistance at *a* every time *a* is negative. This resultant current will be intermittent, half of each cycle being dropped.

If the globe be provided with three electrodes connected to an auto-transformer, as shown in Fig. 2, both alternations may be made to act in the wire, *d*, in the same direction. The direct current produced in this wire is still a pulsating one, but the zero period is reduced to a single instant.

In Fig. 2 the electrode, *c*, is provided with the means mentioned above (to be described later) for breaking down the high negative electrode resistance at all times. The operation is as follows: for one-half cycle the current flows from *x* to *a* through the mercury vapour, *c*, to *z* and back to *x* and *y*. During the second half cycle the flow is from *y* to *b* through the mercury vapour to *c*, to *z* and back to *y* and *x*. A circuit cannot be established between *a* and *b* in either direction since one or the other is always negative, and therefore it would require the 25,000 volts to start a current either way through this path. The line *c z* contains the direct current apparatus to which the converter is to supply power, and will carry a pulsating current.

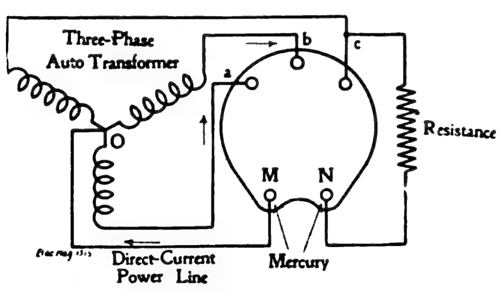


Fig. 3.

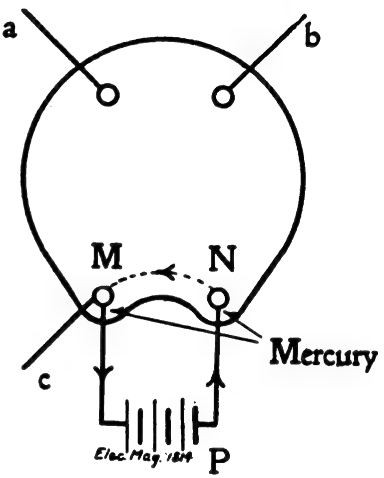


Fig. 4.

Fig. 3 represents one method of continuously breaking down the high resistance at *c*. The small battery, P, is so placed as to send its current as indicated in the figure. When current flows from the battery the electrode, *c*, will remain open to all currents from *a* and *b*, while *a* and *b* are always open to ingoing currents and always closed to outgoing currents. The initial starting of the battery current is easily accomplished by tilting the globe backward and forward, allowing the liquid mercury to flow over the ridge between M and N, thus making a momentary metallic circuit. As soon as this mercury bridge is broken the current is transferred to the vapour without there being an opportunity for the negative electrode resistance to be established.

If polyphase current is used with a similar apparatus, the battery is unnecessary, since at no instant will all the legs of the polyphase circuit be zero; thus the flow of current never ceases. The connections are shown in Fig. 4. As before, operation is started by applying either alternating current or direct current between M and N and rocking the globe, causing the liquid mercury to flow between these points, breaking down the high potential at M. For example, suppose that at the instant the resistance M is broken down, the potential at *a* is just rising from zero, current will flow from *a* to M: 120° later current starts from *b* to M: 120° after this current starts from *c* to M. In the meantime the current in *a* has gone through the cycle. Before the current in *c* reaches

zero, the current in *a* has started on its second cycle, and so on, so that at any instant there is current passing into M.

This practically solves the problem of a continuously operating converter for polyphase currents, but the many private automobile stables in the resident districts, which are reached only by single phase alternating current, as well as many other considerations, create a demand for a single phase self-starting converter. Such a converter has been constructed and, as previously stated, is actually in commercial use in sizes up to thirty amperes. To understand the principle of operation refer to Figs. 3 and 4, where it will be noted that the period of zero current is of an instant's duration, but that at each zero point the 25,000 volts must be applied. If, however, these current waves could be made to overlap even a slight amount, the converter would operate continuously. This is accomplished by inserting a reactance coil in the line *c z*, Fig. 3, which causes a slight lagging in the currents and makes them to overlap. For example, the current from *a* does not become zero until the current has been established in *c* by the rising voltage in *b*. This is, of course, a fluctuating current, but with sufficient reactance in the circuit, *d*, and possibly some reactance or resistance in the main line to give backing, the converter will operate contiunously without going out.

By means of small electro-magnetic devices the converter is made self-starting with the throwing in of the main switches. The bulb is made of glass and mounted on suitable knife-edge trunnions so that on starting it may be easily tilted, causing the liquid mercury to flow between the two liquid electrodes located in the bottom of the bulb. As soon as the operation is established, the tilting mechanism is automatically switched out. The choke coil or sustaining coil is seen below the frame; the variable choke coil used as a regulator may be seen behind the panel with its operating handle passing through the panel. This coil is connected directly in the supply mains.

The apparatus is in no sense a transformer. It does not convert energy from one form to another. Its action is simply that of a set of valves opening and closing gateways and thus allowing currents of one direction to flow through a given line.

Electrical Fires.

In conjunction with our opening remarks to this Section this month we may give some figures in regard to fires from electrical causes which were collated by Mr. C. B. Roulet in a paper presented to the Southwestern Electrical and Gas Association, U.S.A.

He says:

During the year of 1904 and the first three months of 1905 the insurance companies paid losses amounting to $4,127,000 on fires due to defective electrical installations; losses footing up $19,857,000 were reported due from this same cause, but were not definitely proven because fire destroyed the conclusive evidence; $2,870,000 of losses reported due from the same cause were on reliable investigation proved to have been due to other causes. The causes of the fires proved to have been of electrical origin, and which created the above losses, are as follows: 59 due to crosses of low with high potential circuits; 131 due to grounding of circuits on building fronts, water pipes, metal ceilings and gas pipes which caused arcing, burning of holes through the pipes, and igniting escaping gas; 37 due to lightning being brought inside the building by electric wires, and fires caused by the improper protection offered by unapproved fuses; 62 due to crosses of telephone, telegraph and signal circuits with higher potential circuits; 22 due from burning out of armature or field coils and sparking of dynamos and motors; 5 due to overheated resistances; 15 due to loose terminal connections; 16 due to defective sockets or switches; 24 due to heating of incandescent lamps and setting fire to inflammable material near thereto; 14 due to open link and unapproved fuses; 6 due to short circuits of wires in fixtures; 63 due to short circuits of flexible cords; 46 due to overheating of resistances, and defective wiring in electric cars; 14 due to electric heating and cooking apparatus left with the current turned on; 17 due to defective sockets and the use of flexible cord in show windows.

The World's ELECTRICAL LITERATURE

You should carefully study this Section, as it will save you much valuable time. It is the key to the world's monthly Electric Progress.

Power.

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Hydro-Electric Developments at Turner Falls, New Hampshire.	*Elec. Wld. & Engr.* 12/8/05.
Determining the Sizes of Transmission Circuits. C. W. Stone.	*Elec. Wld. & Engr.* 12/8/05.
Electrical Equipment of Manaos Harbour. C. J. Seibert.	*Elec. Wld. & Engr.* 19/8/05.
Hydro-Electric Development of the Ontario Power Co.	*Elec. Wld. & Engr.* 26/8/05, 2/9/05
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Some of the Electrical Developments of Oregon. C. M. Hyskell.	*Elec. Rev., N.Y.* 12/8/05.
Utilising a Power Station Basement. H. S. Knowlton.	*Elec. Rev., N.Y.* 12/8/05.
*The Use of Steel Towers and Wooden Poles. A. D. Adams.	*Elec. Rev., N.Y.* 19/8/05.
Hydro-Electric Plant at Beznau. C. L. Durand.	*Elec. Rev., N.Y.* 19/8/05.
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Witwatersrand Deep Electrical Plant.	*Elec. Eng.* 18/8/05.
Birmingham University Power Station C. A. Smith.	*Elec. Rev.* 28/8/05.
Spacing of Wires of High Pressure Power Lines. W. B. Esson	*Elec. Rev.* 1/9/05.
*Actual Cost of Energy Used in Driving a Small Engineering Works.	*Elec. Rev.* 1/9/05.
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*A Large Power Station Operated with Fuel Oil W. D. Chamberlin	*Power.* Aug./05.
Some New Types of Lightning Arresters. E. Balois.	*L'Eclair Elec.* 2/9/05.

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Electric Motor Applications. J. L. Flinck.	*Ohio Elec. Lht. Assoc.* 16/8/05.
Pole Line Construction. B. L. Chase.	*Ohio Elec. Lht. Assoc.* 17/8/05.

Traction.

Articles.

Freight Development on the Toledo and Western Railway.	*Strt. Rly. Jrnl.* 2/9/05.
*Reinforced Concrete Shops and Car Houses of the Central Pennsylvanian Traction Co. M. D. Pratt.	*Strt. Rly. Jrnl.* 2/9/05.
*Equipment of the New Plank Road Car Shops of the Public Service Corporation. W. Schrieber.	*Strt. Rly. Jrnl.* 2/9/05.
Metropolitan District Railway. Rolling Stock and Traffic Arrangements.	*Tramwy. & Rly. Wld.* 10/8/05.
The Johnson - Lundell Regenerative System.	*Tramwy. & Rly. Wld.* 10/8/05.
The Value of our Canals and What we Ought to do with them.	*Elec. Rev.* 18/8/05.
*Application of Electric Traction to the Transport of Parcels and Letters.	*L'Ind. Elec.* 28/8/05.
Tramway Line in Portugal from Cintra to Praia das Macas. C. L. Durand.	*Elec. Rev., N. Y.* 26/8/05.
*Some Experiences with Drawbars for Electric Cars. W. T. Van Dorn.	*Strt. Rly. Jrnl.* 12/8/05.
Improvements on the Toledo Road.	*Strt. Rly. Jour.* 12/8/05.
*Operating Results of the Valtellina Railway (*See* "Traction" this month). E. Cserhati.	*Strt. Rly. Jour.* 26/8/05.
St. Gall-Speker-Jrogen Electric Railway. H. Somach.	*Strt. Rly. Jour.* 26/8/05.
New Hampshire Traction Co's Portable Sub-Station.	*Strt. Rly. Jour.* 26/8/05.
Transportation Methods on the West Pennsylvania Railroad. W. Brown.	*Strt. Rly. Jour* 26/8/05.
The Brake Shoe Problem.	*Strt. Rly. Jour.* 26/8/05.

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*Data on Electric Baking with Niagara Power (*see* "L. & H." this month).	*Elec. Wld. & Engr.* 12/8/05.
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*Inter-relation of Ballast and Glower in the Nernst Lamp L. A. Terven.	*Elec. Wld. & Engr.* 26/8/05.
Illuminating Engineering and Central Stations. J. R. Cravath.	*Elec. Wld. & Engr.* 2/9/05.
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The Lighting Plant of the Federal Sugar Refining Co., Yonker, N.Y.	*Elec. Rev., N.Y.* 26/8/05.
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Electric Light Engineering. A. S. Hatch.	*Inter. Ass. Mun Eng.* 28/8/05.

Telegraphy and Telephony.

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Development and future Tendencies of the Telephone Art. E. Clement.	*Elec. Rev., N.Y* 19/8/05.
Wireless Telephony. Sir W. H. Preece.	*Sec. G. British Ass.* 30/8/05.
Notes on Some Experiments with Hertz Oscillations. L. L. Evans.	*Electn.* 1/9/05.
Cost of Operating Telephone Exchanges. L. W. Stanton.	*Sound Waves.* August /05.
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Telephone Costs and Maintenance. A. E. Dobbs. — *Sound Waves.* August /05.

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Systems for Rural Line Service. — *Sound Waves.* August /05.

The Telephone Question in France. — *L' Electn.* 2/9/05.

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Principles of Central Energy Systems. W. A. Taylor. — *Sound Waves.* Sept. /05.

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*Armature Losses in Double Current Generators. A. Still. — *Elec. Wld. & Engr.* 21/8/05.

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*Artificial Draught for Boiler Plants. F. H. Davis. — *Elec. Eng.* 11/8/05.

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*Electricity Meters. C. H. W. Gerhardi. — *Electn.* 11/8/05. 8/9/05.

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Barriers in A. C. Switchboard Construction. W. A. Wallon — *Ohio Elec. Assoc.* 16/8/05

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*Methods of Selling Current as Applied to Cities of 20,000 Inhabitants. H. C. Ayers. — *Ohio Elec. Assoc.* 17/8/05.

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Articles.

Manufacture of Electric Automobiles. — *Elec. Wld. & Eng.* 2/9/05.

Duncan Meters. The Man and the Product. — *West Electn.* 26/8/05.

The Electrical Outlook in Japan. — *Elec. Rev.* 8/9/05.

"The Telegraphist's Guide."

By BELL & WILSON. London: S. Rentell and Co., Ltd., Maiden Lane, W.C. Price 2s.

Of books on telegraphy there is a deplorable scarcity in this country, but scarce as they are, no great loss would be sustained by students of the subject if some of the latter-day works had never been elevated to the dignity of print. This laconic criticism does not, in its entirety, apply to the new edition of Bell and Wilson's "Telegraphist's Guide," which has just reached us. It is a work that serves a useful purpose, especially for those who are revising, in preparation for a Departmental or other examination. But as a text-book it is still far from complete.

The authors have apparently aimed at brevity, but although that virtue may be the soul of wit, it is certainly not the soul of inspiration for serious students of science, who require elaboration of detail and lucid and exhaustive explanation of first principles in order to facilitate the task of study and gain a thorough understanding of the subject. Many chapters are fairly complete; those on duplex, and especially bridge duplex, being particularly replete and informative, but others again are so scrappy and meagre in elucidation that they are rendered practically useless for the purposes to which they are dedicated.

What, for instance, can a student find in the following description of the sounder silencer that will enable him to satisfy the requirements of an examiner, who might, perchance, invite a description of that auxiliary of a repeater station?—

"A sounder silencer is introduced into all the circuits. Its coils are wound to a resistance of 200 ohms, and are shunted with a 200 ohm copper shunt, and more recently a condenser has been substituted for the shunt. Currents of ordinary duration do not affect the silencer, but a marking current of 16 to 18 seconds introduces the sounder."

There is a fairly good chapter on wireless telegraphy; but from writers who must surely have heard of the classical experiments in this subject by James Bowman Lindsay of Dundee, in 1853, one marvels at such an introduction as:

"The first practical system of wireless telegraphy was that of Preece, who utilised electro-magnetic induction."

In view of this extraordinary statement it may probably be interesting to remind them that the old Electric and International Telegraph Company tried a system of wireless telegraphy by Haworth in the early sixties, when Preece was superintendent of that company's southern district of England, and over thirty years before he had tried the system which bears his name.

The illustrations have been very much improved, but they still stand in need of change in this direction, and many of them, especially those taken from photographs, might with advantage be omitted altogether, as being in no way helpful to a comprehension of the context. In their next edition, the authors might consider the advisability of incorporating their pamphlet on submarine telegraphy. This would not only introduce another valuable chapter but would obviate the objectionable practice of referring the reader to it on every other page.

Despite the faults enumerated, Messrs. Bell and Wilson are to be congratulated on producing a work which is much more accurate throughout, and far more up to date, than most others. At the modest price of 2s. it is well worth possessing.

"Modern Electric Practice."

Edited by MAGNUS MACLEAN, M.A., D.Sc. Vol. VI. London: The Gresham Publishing Company, Southampton Street, Strand. Price 9s.

In our last issue we reviewed the fifth volume of this work, and in noticing the last volume we must again commend the complete edition to the notice of engineers.

The volume, comprising Section V., concludes the miscellaneous applications of electricity. It opens with telegraphy by A. C. Booth, and the eighty-nine pages devoted to the subject carry the reader from the most elementary principles to quite advanced practice. The treatment is clear and the explanations can be readily followed. Machine telegraphy claims special notice, but some of the more modern systems, such as the Murray, are but briefly mentioned. Wireless telegraphy could easily have formed the subject of a separate section. Telephony is the next subject, treated by Dane Sinclair, and this section contains much useful general data. Electricity in mining follows, by D. Burns, and covers some fifty pages describing electric mining plant. The principles of pumping and haulage are detailed and practical formulæ given regarding each, in addition to descriptions of the apparatus. Coal cutting, shot firing, and drilling conclude the section. Electric cranes are sufficiently important to justify the separate space allotted them, and at the hands of Philip Dawson they are adequately described. Electro-medical appliances are also highly important, and Dr. Dawson Turner has very clearly depicted in word and illustration the chief classes of apparatus used in this field. The last section, from the pen of the late lamented W. E. Langdon, on electric railway appliances brings a singularly complete work on modern electrical engineering to a close. We know of no other work which can fill in exactly the same way the great need for a concise compendium of electric practice as that now completed under the above title.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

Gas Power Plant Manufacture.

Alma Works, Levenshulme.

As an industrial nation we have been unjustly accused of a natural bias towards steam. In reality we have an aboriginal taste for coal, and being abundantly blessed with concentrated energy in this form have always tapped it according to our lights. During the rise and development of steam plant, prophets innumerable foretold a time when the short cut to cheap power from coal, *viâ* gas producers and gas engines, would be taken by engineers in preference to the circuitous path necessitated by steam and its irksome accessories. These predictive utterances are now given substantial confirmation and practical expression at the Alma Works of Masons Gas Power Co., Ltd., which we were privileged to inspect recently at Levenshulme, Manchester.

The uprising of manufacturing establishments such as that we are about to describe is a healthy sign of progress in the domain of gas power, and we are the more pleased to record the enterprise of a prominent firm whose specialities in power plant have met with such conspicuous success. The history of the business commences some twenty years back, when, trading as W. F. Mason, works in Longsight, Manchester, were engaged producing bakery ovens, machinery, and allied apparatus. The now famous Duff grate was first taken up at these works twelve years ago, and developed to the extent that its efficiency and simplicity were placed pre-eminently beyond dispute. This valuable device formed the nucleus of a separate gas producer department, and so great was the demand for the grate that about eighteen months ago new works were commenced upon for its special exploitation in conjunction with other gas-producing apparatus.

The works are well situated in Levenshulme, adjoining the London and North-Western Railway, and are admirably planned with a view to extensions. Some eight

Main Erecting Shop, Alma Works.

acres of land form the site, and of this the present buildings occupy about three acres. Like all modern industrial establishments, the offices at Alma Works are both commodious and comfortable, and their organisation is arranged on rigorously methodical lines. In the matter of equipment they are both ornate and convenient, with a commendable bias towards the latter, and no expense seems to have been spared to ensure cheerful surroundings for the staff. The office block is heated on the Plenum system, and electrically lighted throughout, while the telephone arrangements are very complete. Above the main office, of which we give an interior view, is a large dining-room and drawing office, the latter being exceptionally served with natural light from three sides, artificial light being also derived from inverted reflector arc lamps.

The Works.

The main erecting shop is the largest of the works buildings, being 220ft. long by 50ft. wide. It is abundantly lighted from the roof, and affords plenty of space for the erection of the many large plants manufactured. It seemed quite natural to find the tools, both large and small, driven by electro-motors, as modern manufacturers are now constantly vindicating the claims which these handy power agents have upon them. The machining work chiefly constitutes plate bending, drilling, shearing, punching and chipping, while to a lesser extent turning is also required. For these various operations the most modern tools are installed, with individual motor drive in the case of the larger types. A machine shop, 125ft. long and 27ft. wide, opens into the main erecting shop, and is equipped with a number of lathes and small drills, together with fitting benches. Both this shop and the erecting shop are served by overhead travellers, the latter having a 10 ton electric crane. The views we give of these shops clearly indicate their proportions and the character of the work put through them At the opposite end of the erecting shop is a plate and angle-bending shop, where the steel plates for producer cases and the accessory apparatus are bent to shape. A gas fired "Weardale" patent furnace for reheating plates is used in this shop. The bending rolls are operated direct by a 25h.p. motor, driving through gearing. This was an interesting example of the individual motor drive, and one which fully testifies to the ease and convenience of electrical operation. Adjoining this tool was a large shears and punch operated by belt from a motor mounted above the main supporting column, this, again, being a typically neat combination.

Exterior View of Alma Works, Levenshulme.
(Office Building in foreground and Main Shops in rear of Picture.)

View in General Office, Alma Works.

extended to allow of the erection of two 80h.p. gas-dynamos for lighting and power purposes. When this plant is in operation the company will be possessed of an excellent combination for the inspection of prospective clients, who will be afforded visible evidence of the chief uses of power gas.

At the present time, however, types of the two gas producer plants made at the works can be examined in operation. One of these is the anthracite suction plant in the power house, and the other a bituminous plant erected at the back of the main building. This latter comprises a Duff-Whitfield producer and gas cooling, scrubbing, and washing apparatus. The suction plant is in constant use, but the

The smithy, under the same roof with the plate shop, is fitted with down-draught forges, supplied with blast from a motor-driven blower, and to the same motor the exhauster fan for the fires is coupled. The compactness of the drive in this case was evident from the manner in which the motors were bolted to the wall and belted to their work on the floor below. A large pattern and wood-working shop gives on to the erecting shop, and is provided with a roomy gallery for storage purposes. A stores for castings, finished and general work, also adjoin the erecting shop, as does the power house, which at present contains a 40h.p. suction plant and gas engine driving an air compressor for the pneumatic tools.

Electrical energy for both lighting and power is at present purchased from the Manchester Corporation, but it is intended that the power requisite shall be derived from gas plant. To this end, the engine room will be

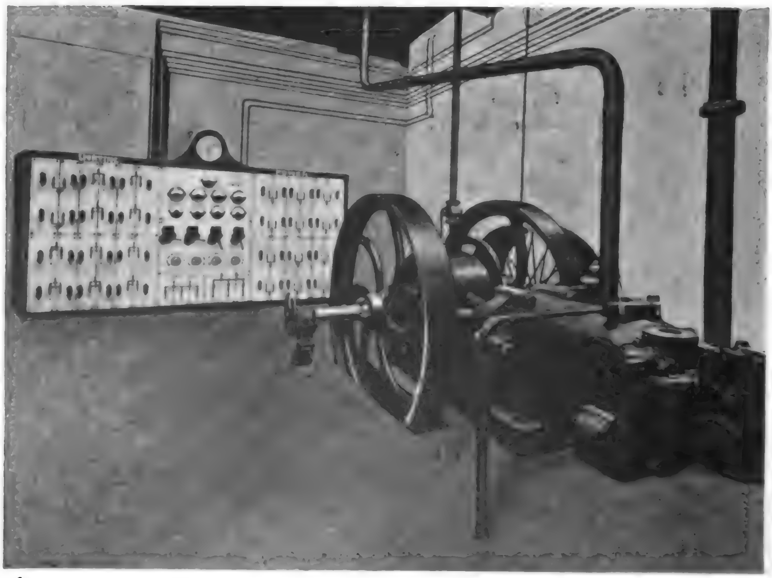
Part of Main Erecting Shop, Alma Works.
(Duff Grates and Producer Hoppers in the foreground.)

THE DRAWING OFFICE, ALMA WORKS.

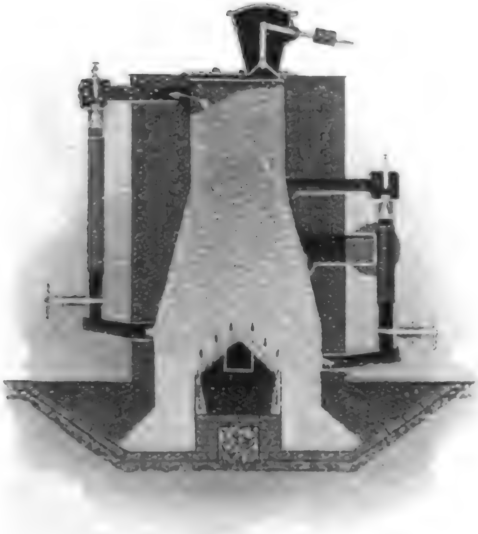
bituminous producer can be started up at short notice when it is out of commission.

CHIEF PRODUCTS.

A variety of designs in gas power plant is manufactured at the works. The chief product, and one which predominates among the general output, is the Duff patent grate, which has practically revolutionised the art of power gas production. The form and application of this grate can be seen from the adjoining section (p. 201) through a Duff-Whitfield gas producer. It constitutes a blast grid of **A** shape, upon which the incandescent fuel partly rests, the remainder being supported by the ash rising from the bottom of the water trough below the producer. In practice, this device has proved remarkably efficient, as it evenly distributes the blast from the centre of the fuel mass and effectually prevents the escape of free air up the sides of the producer. It is the only grate extant which admits of the uninterrupted rise of steam and air through the fuel at the centre of the producer. This action facilitates the recovery of the maximum of ammonia from the nitrogen in the coal. The even distribution of the air also ensures the more complete combustion of the fuel, and a smaller quantity of unconsumed residue. According to the company's records some 600 Duff producers are in use in this country alone, no less than 66 being installed in the



40H.P. GAS ENGINE AND SWITCHBOARD IN POWER HOUSE, ALMA WORKS.



Duff-Whitfield Slack Coal Gas Producer.

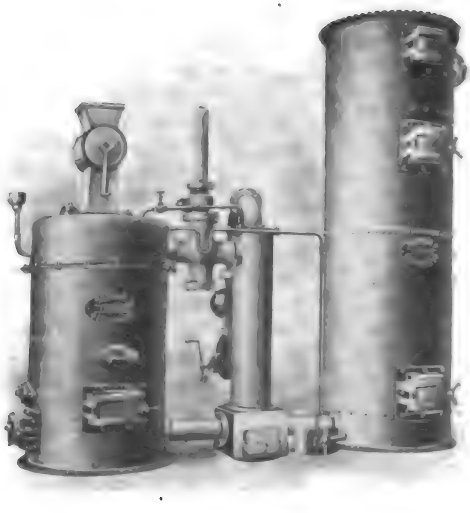
Middlesbrough Works of Messrs. Bolckow, Vaughan and Co., Ltd., and 58 at Cammell, Laird and Co.'s Sheffield works. A more detailed description of this producer and the other apparatus referred to later will be found in the Gas Plant Supplement this month.

Another important branch is that devoted to suction gas plants, which are built in sizes up to 100h.p. These plants are becoming very popular, chiefly on account of their extreme simplicity and automatic action. With coal at 20s. per ton, one horse power hour can be obtained from a suction gas plant for one-tenth of a penny. We illustrate the type developed at Alma works, and the comparative fewness of the working parts will be at once evident. The complete plant comprises generator, vaporiser, and washer and cooler, the whole occupying a floor space of about 20sq. ft. for a 40h.p. plant. A hand fan is provided for starting, and once the production of gas commences and the engine is running no further attention beyond supply of fuel is needed. For country installations a more ideal form of power producer would be difficult to conceive, and when all the factors of economy and simplicity are taken into account by steam users, the adoption of gas plant will in most cases be considered a desirable expedient. The thermal and mechanical efficiencies of the gas engine are already beyond dispute, and with a reliable gas producer the power user should need no further inducement to make the change.

The Duff-Whitfield bituminous slack producer is made in both large and small sizes and with the most encouraging results. The old difficulties of ridding the gas of its ammonia and other hydro-carbons have been successfully overcome, and the most exacting gas engine maker will have no cause to complain of the gas analysis. The illustration previously referred to depicts the producer in section, and apart from the Duff grate the feature of the Whitfield patent will be noticeable in the circulators at the sides of the producer. By the use of the ejector principle, the tarry vapours are drawn from above the fuel and also from near its centre, and made to travel through the fire zone, where they are purified and converted into free gas, which emerges from the producer at a point midway between the green coal and the grate.

A speciality is also made of the manufacture of the Weardale patent furnace for heating slabs, plates, angles, piles, &c. This furnace is constructed for gas firing and, we are informed, is the only furnace of its kind with which the waste heat can be used for raising steam in boilers. It can be built without excavations, and quite obviates all possibility of water trouble and, consequently, can be erected in waterlogged situations such as shipbuilding yards.

Furnaces are also made for heating by producer gas for all purposes, among which



Masons Suction Gas Power Plant, 40b.h.p.

we may mention core drying ovens, annealing, calcining, forging, case hardening, re-heating, riveting, and the melting of metals.

The works at Levenshulme accommodate some 250 workmen, and, as we have already stated, are well situated in the matter of extensions. The original company of W. F. Mason, Ltd., has recently undergone reconstruction, and is now known as Masons Gas Power Co., Ltd. It is interesting to note that most of the old staff remain with the new company, a fact which should contribute largely towards the success of its future efforts. Through the courtesy of Mr. Chas. Guest Norris, the general manager, we were afforded facilities for inspecting the works, and our thanks are due both to him and to Mr. Thos. Wright, A.M.Inst.C.E., M.I.Mech.E., the works manager, who kindly conducted us through the shops. In concluding this necessarily brief account, we must express our gratification at the expansion of a concern which promises to speedily eclipse its already enviable records in the field of gas power plant manufacture.

Water-Raising Appliances.

THE presence of water-bearing strata in the neighbourhood of electric power stations is more frequently ignored than not, and negligence to confitm the fact is costing many stations hundreds of pounds yearly for purchased water. Large manufacturing concerns are eager enough to avail themselves of a borehole if such can be sunk to water depths, and object on principle to pay heavily for what is obtainable at much less cost. Now water is as much the life of a station as coal, and the chief engineer is sufficiently business-like to get his fuel in the best and cheapest markets. He will also exercise every known precaution to procure the right kind of coal for his boilers and the class of load which his station supplies.

The very marked difference in the cost of water taken from the local main and that supplied from below ground level should be sufficient incentive to the sinking of trial holes in search of water. Any price from 1s. per 1,000 galls. downwards is now paid by central stations for boiler feed water, whereas the same quantity can be drawn from borings at less than 1½d. It is a matter of simple

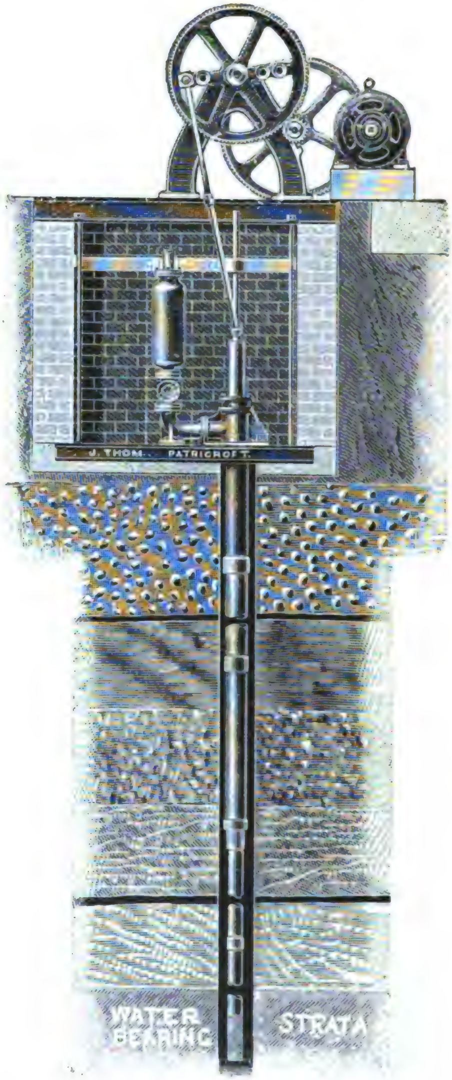


FIG. 1. ELECTRIC BOREHOLE PUMP FOR RAISING WATER.

arithmetic to ascertain the annual saving affected by this arrangement.

Again it cannot be pleaded as an excuse that boring plants are costly or that experts in finding water are few and unreliable. We do not refer to water diviners so called, whose gymnastic twigs deceive both the "diviner" and his client. The art of reaching subterranean aqueous soil is as much alive to-day as ever it was; in fact more so, because the demands for water have grown out of all proportion to the means of economically meeting them. As a practical exponent of it with many years' varied

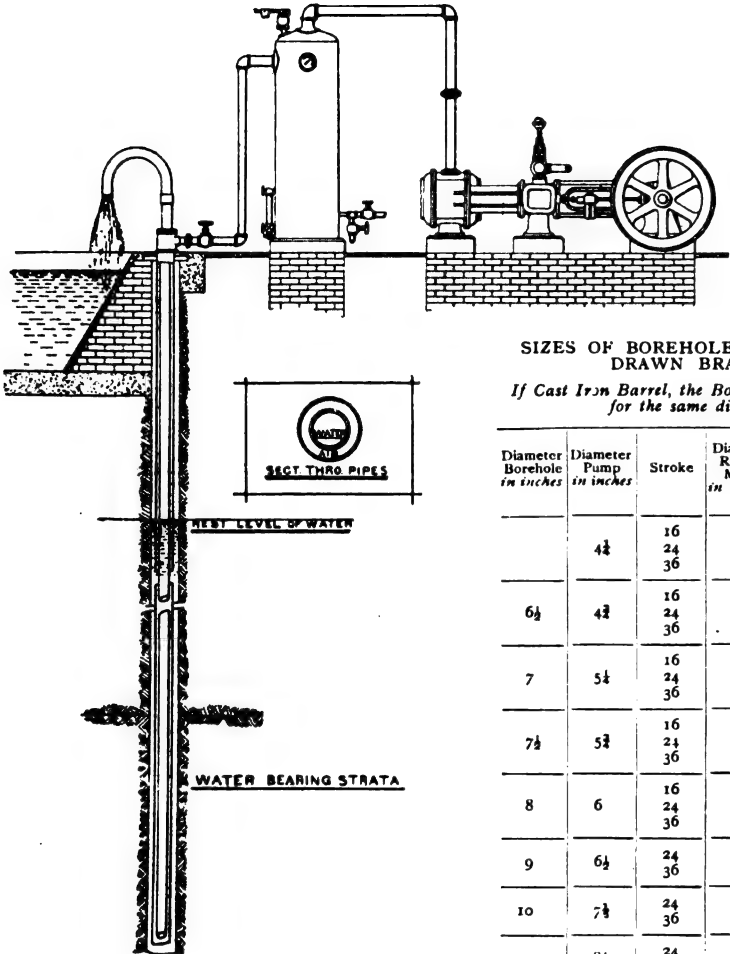


FIG. 2. THOM'S IMPROVED AIR LIFT PUMP.

experience we may mention John G. Thom, Canal Works, Patricroft, to whose specialities in this province we would like to draw the attention of water consumers. Both boring plants and water-raising apparatus have been standardised by him, and every class of work of this nature can be undertaken.

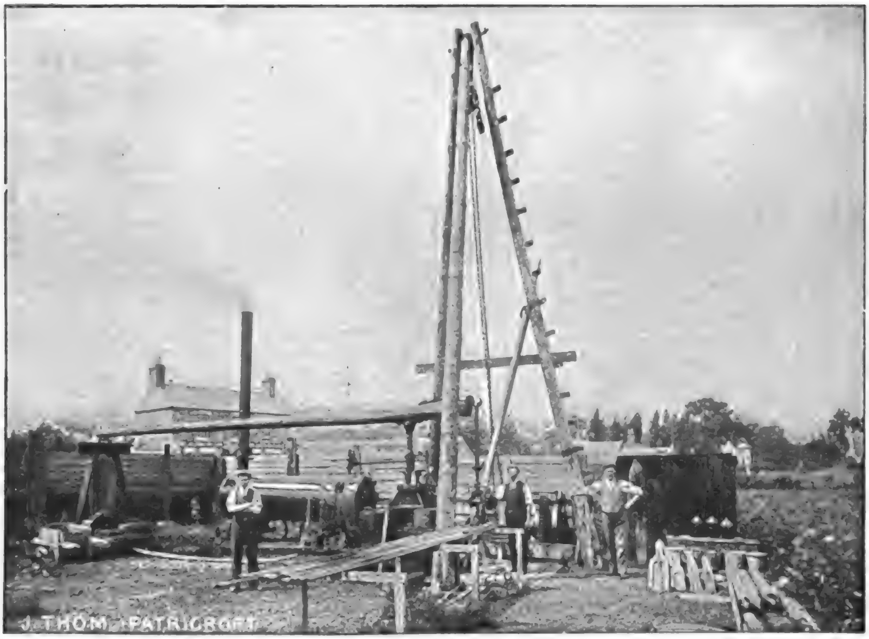
In Fig. 1 we illustrate an electric borehole pump which is made in sizes to suit the water supply of the boring and the needs of the customer. The pump is enclosed in a brick chamber just below ground level, and the gearing for the pump rod is mounted on a foundation plate or columns at the ground level. This makes an efficient and handy combination when electric power is available. Similar pumps can be arranged for either direct steam drive or by belt from any convenient power source. For the guidance of engineers we give a table showing the delivery in galls. per hour from various sized boreholes and with certain pump speeds.

SIZES OF BOREHOLE PUMPS WITH SOLID-DRAWN BRASS BARRELS.

If Cast Iron Barrel, the Borehole will require to be larger for the same diameter of Pump.

Diameter Borehole *in inches*	Diameter Pump *in inches*	Stroke	Diameter Rising Main *in inches*	Revols. per minute.	Theoretical deliv. in Galls. per hour.
	4¼	16 24 36	4½	30 25 20	1473.6 1842.0 2210.4
6½	4¾	16 24 36	5	30 25 20	1840.8 2301.0 2761.2
7	5¼	16 24 36	5½	30 25 20	2248.8 2811.0 3373.2
7½	5¾	16 24 36	6	30 25 20	2697.6 3372.0 4046.4
8	6	16 24 36	6½	30 25 20	2937.6 3672.0 4406.4
9	6½	24 36	7	25 20	4308.0 5169.6
10	7½	24 36	8	25 20	5736.0 6883.2
11	8½	24 36	9	25 20	7368.0 8841.6
12	9½	24 36	10	25 20	9204.0 11044.8
14	11½	24 36	12	25 20	13480.0 16170.0
16½	13½	24 36	14	25 20	18600.0 22320.0
19	15½	24 36	16	25 20	24510.0 29412.0
20	16	36 48	17	20 15	31320.0
21	17	36 48	18	20 15	35370.0

Another speciality to which we may direct attention is an improved method of raising water by means of compressed air. As will be seen from Fig. 2, the air lift is extremely simple, consisting of an air compressor, receiver, air pipe, and delivery pipe for the water.



THOM'S BORING PLANT IN OPERATION DRIVING BOREHOLE FOR WATER.

Air under the necessary pressure and of suitable volume is admitted to the air pipe, which is immersed inside the delivery pipe to a suitable depth in the water, where alternate bands of water and air are formed. The pressure per square inch of the column thus made up of air and water is less than the pressure per square inch outside the pipe, consequently the water flows continuously up the pipe. As the force lifting this column of water is the difference of the heads of water inside and outside of the pipe, the height to which the water can be raised depends on the immersion of the air pipe, thus the higher the lift the deeper the immersion, therefore the borehole requires to be proportionately deep.

Under certain conditions it will be found that this improved air lift system of raising water is preferable to pumping, as the absence of any moving parts underground secures a great reduction in the cost of repairs. It requires also little supervision, and has a great advantage where the water is impure, as the aeration has been found to improve its quality and make it fit for use. Three times more water can be raised from small boreholes by this system than any other. In a great many boreholes sand interferes with the smooth working of pumps, but of course it does not affect the air lift. Where the borehole is in an inaccessible or isolated spot and it is not convenient to erect pump-house, boilers, &c., the compressor may be placed where convenient and the air conveyed by pipes to the borehole, or even several boreholes far apart.

We hope that station engineers for economy's sake will carefully analyse the cost of obtaining water either by pumping or the air lift method mentioned above, as we are convinced they would quickly repay the capital outlay entailed by the sweeping reductions affected in the water bill. Central station economies are being reduced to a fine art, we will admit, but here is an instance in which much remains to be done to curtail a heavy item of expenditure.

In concluding our reference to the specialities of John G. Thom, we may say that he is prepared to give detailed information on the subject, and to present figures, so dear to every engineer, in support of his contentions. Among other specialities are steam pumps, ram pumps, injectors, air compressors. Full particulars of these will be found in his elaborate catalogues, which also contain a large quantity of practical data, and interested readers should communicate with the Patricroft Works.

Electric Driving and Motor Control.

ELECTRIC driving is coming more and more into use for all kinds of machinery, and it is a generally recognised fact that it is cleaner, more economical, and more efficient than any other method. It is not our intention to deal in this article with the commercial side of this question, but rather to give such particulars as will be of interest to the practical engineer.

Our first illustration gives a general idea of the appearance of the Stellite continuous current motors, built by the Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham. They are made in a range of sizes from $\frac{1}{16}$h.p. to 15h.p., and are supplied either of the protected type, as shown, or totally enclosed. The motors have been very carefully designed and are of substantial construction, the aim of the makers having been to produce a thoroughly satisfactory and reliable machine. A large number have been supplied to the British, Japanese, and other Governments for driving workshops, machinery, lifts, &c., and specially for use on shipboard for driving fans, hoists, and other parts of the equipment. These motors have all successfully passed the rigorous tests imposed by these authorities, and it speaks well for the Stellite machines that they have met with such success. The body, which is of cast iron, is provided with a register into which the commutator end cover fits, the two being held together by screws. The poles are of laminated charcoal iron, having the tips specially shaped to produce sparkless commutation. The armature discs, of best re-annealed charcoal iron, are carried directly on the shaft, the latter being ground all over, thus producing truly cylindrical surfaces. It may here be mentioned that all parts are machined to limit gauges, thus ensuring interchangeability. The motors are arranged so that the bearings may be turned and the feet fixed to a wall or ceiling.

The armature coils consist of high conductivity double cotton-covered wire, taped with specially prepared insulating tape. Both before and after taping, the coils are insulated by means of special vacuum drying and impregnating plant. A double thickness of mica is placed in the slots before the coils are put in place. The commutator is built of hard drawn copper bars, insulated by best amber mica. The sleeve is securely keyed to the shaft, thus ensuring no strain coming on the connections. The field coils are carefully wound on formers, insulated with mica inside and special linen tape outside, and impregnated in a vacuum chamber in a similar manner to the armature coils. The bearings, which are of gun-metal, are fitted with ring lubrication, the rings running in oil chambers of ample size.

Other standard lines are motors fitted with back geared shafts for reducing the speed to about one-sixth, and for larger reductions worm gear is fitted. In the case of the former, a raw-hide pinion is fitted on the armature spindle, and a cast iron spur wheel on the secondary shaft. Both the pinion and wheel have machine-cut teeth. The secondary shaft runs in self-oiling gun-metal bearings.

For reducing the speed from 10 to 1 and upwards, a worm gear is used. This is enclosed in a cast iron case, and the worm, cut from a solid steel shaft, runs in an oil bath, thus ensuring efficient lubrication.

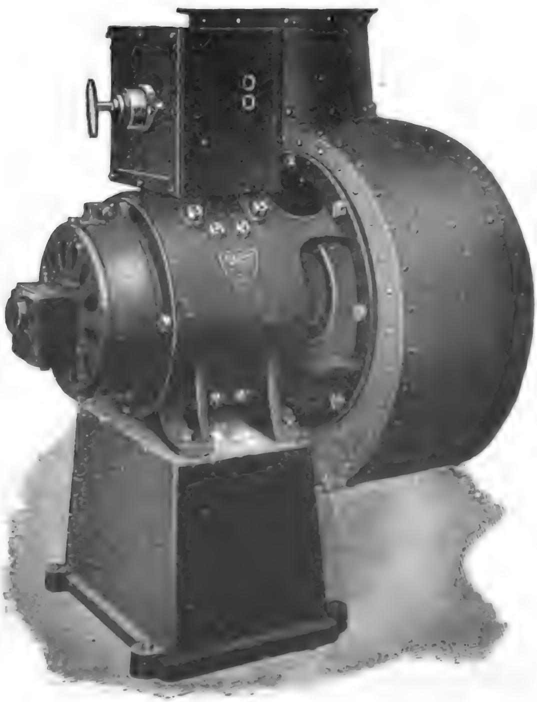


FIG. 1. STELLITE CONTINUOUS CURRENT MOTOR AND FAN.

Ball thrust bearings are fitted to the worm shaft. The worm wheel is of phosphor bronze, mounted on a cast iron hub. An oil gauge is fitted and a draw-off cock provided. Special attention is paid to the accurate machining of the gear, and a high efficiency is obtained.

A speciality is also made of crane motors. These are designed for all powers up to 30h.p., and are series wound. The motors are rated on the half-hour basis, but any other rating can be quoted for. (Complete electrical equipments of motors, controllers, switches, conductors, insulators, &c, can be supplied at short notice.) Other manufactures of this company are sewing machine motors suitable for driving domestic sewing machines; $\frac{1}{16}$h.p. and $\frac{1}{8}$h.p. motors for electric flash signs, &c.; small electric drills for watch and instrument makers, polishing motors for small work, and portable electric drills.

Complete lines of electrically driven pressure fans, as shown in Fig. 1 are also made. These can be supplied to give any quantity of air up to 15,000 cubic feet per minute at 1in. w.g. pressure. Exhaust fans are made for exhausting hot or foul air from kitchens, workshops, &c., and will pass up to 45,000 cubic feet per minute.

In connection with motor control, we give some particulars of the controllers made by the Electric and Ordnance Accessories Co., Ltd., Stellite Works, Birmingham, who are now engaged on some very large and important contracts for controllers for cranes and variable speed motors. Not only are they equipping Messrs. Harland and Wolff's shipbuilding yard at Belfast with single and double voltage controllers, but they have on hand some very large yearly contracts for crane controllers fitted with standard and special features.

We give herewith some of the company's standard manufactures in this direction:

1. Controllers for variable speed motors, single voltage.
2. Controllers for variable speed motors, double voltage.
3. Controllers for cranes for series motors.
4. " " " " shunt "
5. " " " fitted with rheostatic brake points in either direction.
6. Controllers for cranes fitted with solenoid brake points.
7. Controllers for cranes for special slow hoisting (foundry type).
8. Controllers interlocked with p.d. switch.
9. " fitted with ove load and no release.
10. Controllers fitted with spring return.
11. " " " universal return.
12. " for three phase motors for rotor circuits.

The resistances that are supplied with the above types of controllers are built up specially to meet the requirements of the customer, the material generally used being special wire or grids of a special mixture according to the size of the controller. The first two items, controllers for variable speed motors, are designed to meet the standard voltage—220 volts and 440 volts. The cycle of operations to obtain the various speeds is as follows, commencing with the "off" position:

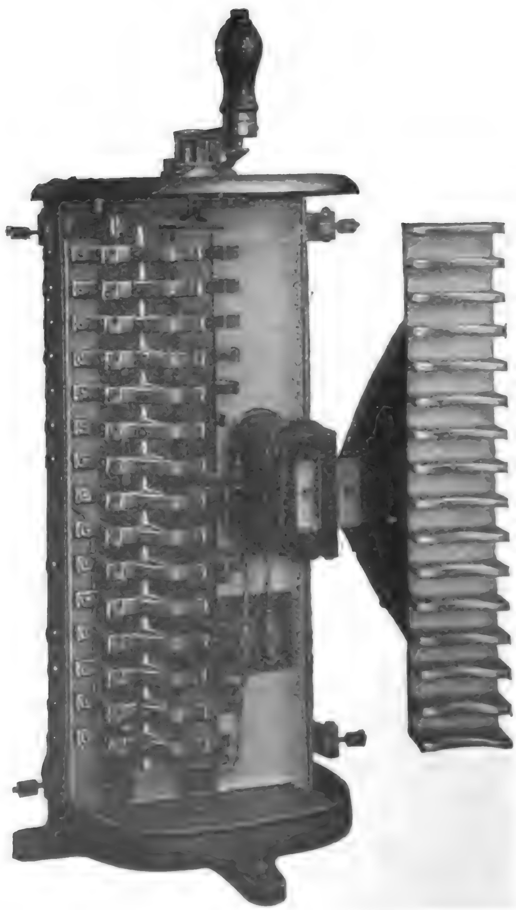


Fig. 2. Stellite Motor Controller for Heavy Service.

Off position—

1. Brake magnet excited—brake lifted.
2. Shunt resistance connected across kicking coil

First starting position—

1. Ditto as regards brake magnet.
2. Shunt excited across 440 volts, and no resistance in series with its winding, giving maximum strength of field.
3. Armature in series with all starting resistance across 220 volts.

Second to fifth starting positions—

1 and 2. Ditto.

3. Armature starting resistance gradually cut out.

Sixth running position—

1 and 2. Ditto.

3. starting resistance all cut out and armature direct on 220 volts, giving lowest normal speed.

Then follow twenty shunt regulating positions, resistance inserted in series with field winding. To obtain a further increase in speed the motor armature must be brought across the 440 volt mains. To prevent the motor slowing down, this movement must be made quickly. First, the shunt resistance is short circuited to give a strong field, and then the armature resistance is inserted in two sections to reduce the arc formed on breaking before changing over to the first step on the 440 volt circuit. The next series of operations repeats that detailed on the 220 volt circuit, with the exception that the armature resistance is cut out in three sections, giving four speeds instead of six. It will be seen that no fewer than forty different speeds are obtained by shunt regulation; this is apart from armature regulation, the latter being very seldom adopted, as this resistance is used for starting purposes only. This type of controller is also fitted with magnetic brake point, the latter being de-energised when the controller arm is brought to a stop beyond the "off" position, thus allowing the gravity brake to act. To take the "kick" of the current, a non-inductive coil is supplied, as otherwise serious arcing would occur and eventually destroy the controller. In design the controller is very similiar to those that are used on cranes and tramcars; it is operated with a lever handle.

The shunt regulating rheostat is contained in the controller car case, the armature resistance being supplied separate. The whole arrangement is compact and every detail has been carefully considered from both the electrical and mechanical points of view, with the result that the Stellite controllers meet with the highest appreciation of all buyers.

Third to seventh items.—Crane controllers are designed specially to meet the exigencies of this class of trade, and will meet the various requirements specialised for this work with the greatest efficiency. They are reversible, and fitted with magnetic blow-out placed in series with the armature and fitted at the best point of vantage, *i.e.*, in the middle of the arm or pole piece, thereby producing a strong field throughout the required range. All parts of this controller are easily accessible, and each component can be easily replaced with the minimum of trouble. All the fingers on this controller are not only protected by the magnetic blow-out, but are placed in fire-proof chambers, which renders any arcing from one contact to another impossible. The controller is neat in design, and its adaptability to meet all conditions of service has placed it in the front rank of this class of goods, as well as claiming the high appreciation of all buyers. Item 5.—Controller fitted with rheostatic brake. The armature being short circuited across a regulating resistance, the motor becomes a generator, the current generated being dissipated by the production of heat in the resistance. The sixth item gives the controller fitted with solenoid brake, in which, when the supply is cut off from the armature, the brake is put on by the action of a spring which instantly throws the operating gear out of action.

The seventh item gives a controller of a special slow hoisting type, which reduces the speed of the motor to 10 per cent. of its maximum.

This controller is specially adapted for foundry work such as lifting cores where slow lifting is essential.

No. 8 item is a controller fitted with a double pole switch, which is interlocked with the controller barrel, thereby compelling the operator to close the main switch before regulating the armature. Concerning the overload and no load release, the operator has to return to the "off" position and remake the circuit when an overload occurs. In all the above types of controllers it will be noted that almost every standard is met with, and that the Electric and Ordnance Company have specialised in this direction, setting apart a special department with modern machinery to negotiate orders with promptitude.

Every detail of the controllers is the result of experimental and practical tests, and decisions relative to same are only reached when the best possible effect is obtained. The foregoing is only an outline summary of the Stellite controllers, but will show that the above firm is fully equipped to deal with all classes of goods of this character.

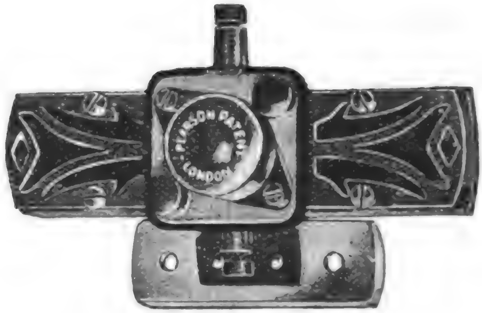


FIG. 1. EXTERIOR OF PEARSON FIRE ALARM.
(Hal actual size. Set at variable temperatures from 50° F. upwards.)

An Electric Watchman.

By M. I. S. A.

The Pearson Automatic Fire Alarm.

IN these days that may claim to be woven of the fibre of science, and rendered fascinating by the variety and attractiveness of her designs, the now ancient and trite saying, "You press the button and we do the rest," is a long march behind our requirements where reliability and prompt and right action in emergency are necessary to minimise the chances of loss, danger, and death. We cannot be depended on to "press the button." Presence of mind is an admirable quality, but like genius it can neither be bought nor bribed. Scientific invention has demonstrated that it is easily possible and wisely preferable to dispense with reliance on the unstable human quality generally distinguished by the term "presence of mind," and to depend on something better than scatter-brained action or equally scattered-brained inertia. It has been brought to pass that an outbreak of fire, no matter how insignificant the spark, shall signal itself.

"A wise man thinks beforehand, and a fool afterwards," but the automatic fire alarm puts itself into action at the moment—the money-saving, life-saving moment, whether that moment be at noon or midnight, at sunrise or sunset, or in the hours that lie

FIG. 2. INSTALLATION OF INDICATORS FOR PEARSON FIRE ALARM.

SHAKESPEARE'S HOUSE, STRATFORD-ON-AVON, PROTECTED BY PEARSON AUTOMATIC FIRE ALARM.

between! Inside a building, outside a building, in cellar and on roof, or in the intervening spaces, it is all one to the self-acting, self-adjusting little instrument that stands as truly the servant of a rising temperature as was the slave of Aladdin's Lamp to its fortunate possessor. With the speed of the lightning flash it delivers its message, and with an unmistakable persistency. If the buildings be empty of human occupants, it matters not, the alarm is raised at the fire station and the stock saved.

The object of the Pearson fire alarm is to give, at the earliest possible moment, notification of the existence of undue heat or of an outbreak of fire. The system is entirely automatic, and requires no human agency whatever to operate it. The aim of the inventors has been simplicity with efficiency, and results prove that this end has been attained. In installing a building with the Pearson alarm, automatic heat detectors, or thermostats, are so fixed as to protect every portion of the premises, particular attention being given to those places where an outbreak of fire might, under ordinary conditions, remain unobserved until a dangerous stage had been reached, and the usual primary means of coping with the outbreak would be of no avail. With the Pearson alarm should any heat detector, or thermostat, be subjected to more than its limit of temperature (which can be varied), the fire call is at once given either direct to a Fire Brigade station, to one of the company's central stations—in telephonic communication with the fire brigade; or in the case of an isolated installation, by a gong fitted inside or outside the building at any convenient spot.

The thermostat is the part acted upon by heat, and is therefore the primary part of the system. The company has taken every possible measure to procure a thoroughly sensitive and reliable thermostat. The illustration (Fig. 1) shows the exterior of the latest type, and is about one-half the actual size of

AT ETON. COLLEGES AND HOUSES PROTECTED BY PEARSON FIRE ALARM.

the instrument. Fig. 2 depicts an indicator board with fittings and accessories complete. The advantage of this type of thermostat is that it can be set so as to give the alarm at any required temperature by moving a pointer. When the instrument is fixed in a building, the pointer and dial are protected by a metal cap, so that no tampering or alteration of the setting can take place. When fixed, the thermostats can be coloured to harmonise with the surrounding decorations, and are no disfigurement to the rooms in which they are installed.

In the case of this thermostat, the alarm is given by the heat acting on a metal strip, causing expansion, and thus closing the electric circuit. The extreme simplicity of the device is evident on the most cursory examination. The instrument, after operation, re-sets itself, and is at once ready for service, and human intervention is thus obviated, and an absolutely perfect automatic action attained.

The Attractiveness of Exhibition Stands.

It is very evident from the progress made by industrial exhibitions during the past twelve months that engineers now realise the value of such publicity for placing their goods before the notice of buyers. In this connection a great deal depends upon the attractive way in which the various stands are erected. The existence of special exhibition stand fitters clearly indicates that good work is only possible after many years' experience, and by using best material and engaging the best men.

We have had an opportunity recently of investigating the manner in which Messrs. F. Hillier, of Shirland Road, Paddington, W., carry out such work, and we can assure our numerous influential readers that commissions placed with this firm will not only be executed in a most efficient manner, but at prices which will be found to distinctly justify their patronage. The principal, Mr. Hillier, has had a whole life of experience in this particular work, and possesses a stock capable of meeting the demands of any class of advertiser in the kingdom. Work entrusted to him is carried on under his own personal supervision, and the numerous testimonials he has received from many prominent British firms are in themselves a criterion of the way in which he has always satisfied his clients.

The day of exhibitions has come, and as THE ELECTRICAL MAGAZINE has always endeavoured to give its readers the best advice in all matters, we should be remiss did we fail to point out that at any time our supporters anticipate placing their goods before the public at any forthcoming exhibition, efficiency will be provided and low rates ensured if they place their work in the hands of Messrs. Hillier.

It is our pleasure to state that so far as Messrs. Hillier are concerned, a lengthy connection in this class of work has thoroughly equipped them for carrying out all requirements, on a large or small scale, and the same personal attention is bestowed on the small patrons as upon the large ones. Their method of meeting the requirements of stand holders allows them to supply everything either on hire or sale, from the smallest detail to a complete stand, and if necessary furnished and fitted with electric light. This in itself is an advantage as it enables the stand holder to instruct one person instead of a number, as would apply in the case of minor stand fitters.

Few exhibitions have been held in the country to the attractive appearance of which Messrs. Hillier have not contributed in the most material manner, and in several cases within recent years the stands fitted by them have proved a striking testimonial to the energies of the firm which has now established itself in the foremost ranks. Messrs. Hillier have two establishments, one at 150, Shirland Road, and the other at 96, Fernhead Road, both at Paddington, London, W., and also a branch office at Liverpool Road, Islington. Any of our supporters who anticipate exhibiting at forthcoming exhibitions could not do better than communicate with this firm in their own interests.

A Novel Pipe Bending Machine.

We were much impressed during our preliminary round at Olympia inspecting stalls in embryo with the extremely neat bend in the wiring conduit about the building and stands. Sockets and elbows were conspicuous by their absence, and we were naturally inquisitive as to how it was done. On making enquiries we found that a singularly efficient bending machine was at work twisting the steel barrel, without heating, into the required shape. The device is known as the Kennedy patent bending machine, and comprises a simple arrangement of rollers and guides actuated by a large worm driven disc. A star wheel with long spokes provides the necessary leverage, and one man can easily bend brass or copper tubing or steel pipes up to one inch external diameter. Messrs. John Barker and Co., Ltd., of Kensington West, are exploiting the machine, and will exhibit it together with specimens of its work on their stand at the Olympia Electrical Exhibition. Wiring contractors should make a point of inspecting it.

The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. IV. No. 4. (22nd Issue.) LONDON. OCTOBER 28, 1905.

Olympia, 1905.

WITH pride and satisfaction we place this issue of THE ELECTRICAL MAGAZINE in the hands of our readers. It simply exemplifies what can be done by persistent effort, rightly extended and legitimately carried out.

In the march of electric progress nothing speaks more eloquently for the advancement of our great industry than the success of the high-class technical periodical which it has called into being. It is necessary and essential that the prosperity of the electrical manufacturer and that of the trade journal voicing his interests should proceed on parallel lines—side by side. If a new paper starts in a field already, as some may imagine, overcrowded, and is able to show that the interests it claims to serve are advanced thereby, it has a right to expect the support of the trade and industry, and the manufacturer is wise in giving that support. Further than this, the manufacturer who has anything to sell and fails to take advantage of the opportunities placed before him must have something lacking in commercial instinct, and his rivals with more acumen—those who read, mark, and learn—will get ahead of him.

It is the merest folly for the electrical man who values his business interests to treat the legitimate technical journal with unconcern or mistrust. This, we regret to find, is the case with a number of firms. But the manufacturer of Great Britain has yet to be educated into modern methods of publicity, great as has been the advance made, largely through the efforts of the recent, more up-to-date, and necessarily virile newcomers in the field of industrial journalistic exploitation.

Among the latter THE ELECTRICAL MAGAZINE has forged ahead into a position of undeniable influence and power. Apart from this we know of no electrical paper to-day which does not fill a useful purpose—some more, some less. What is essential manufacturers should recognise is, that without the great and unquestionably valuable services rendered by the electrical Press, the electrical business of this country would never have been in the position it is to-day, and that the prosperity which we hope and believe is looming in front of the trade will be largely attributable to the conscientious and

assertive efforts of the engineering journals which have so assiduously served the fraternity. Without a word of disparagement for those who started and pioneered electrical journalism in this country, however, we are compelled to call attention to the developments which have taken place of recent years in this connection; and naturally, and we believe justly, we place in the forefront the advent of THE ELECTRICAL MAGAZINE.

When this journal was launched, it was predicted in certain quarters that its sphere of operations would be strictly limited, but it has absolutely justified its pretensions, filling a widening gap which was waiting to be bridged; and its immense utility is exemplified in an eloquent manner by the present issue. This exceptional number is produced as a fitting record of the successful consummation of an Exhibition which cannot fail to prove of lasting benefit to the industry with which we are all identified. The other electrical papers have published many articles upon the Exhibition and exhibits, and in one way or another have advanced the mission which the Exhibition was intended to serve; but it has been left to THE ELECTRICAL MAGAZINE to produce what may be fittingly termed a record. No other journal has been able to get together so much information, or to treat the material at disposal in such a style. In a word, within the covers of one issue this magazine holds a brief for the Exhibition and the firms represented there, and has endeavoured to portray in a clear, succint style everything of value that space and opportunity permitted to be recorded. Our great regret is that there were a number of big and reputable firms prominently identified with the electrical industry who were not present at Olympia. It might be said that there was not room for all, but the thing could have been managed had the firms in question come forward, and we think it would have been to their undoubted advantage to have done so. For instance, the spacious gallery was not filled by a long way, and a number of firms showing accessories could have been relegated to that portion of the building most suited for such exhibits, which would have left space in the body of the hall for heavier material. This by the way, however. What we are now more immediately concerned with is the success of our own efforts to present to the electrical world—and all and sundry interested in electricity, or who may be educated up to its uses for lighting, heating, or power purposes—a production which we confidently believe will not only remain as a permanent document of interest, but which will, in its broadest sense, be of the greatest possible value and utility to contractors and buyers the world over. We recognise and acknowledge the sagacity and enterprise of those firms who have supported our advertising pages, but at the same time we are under no obligation to anyone in the production of this issue for the simple reason that we have endeavoured impartially and truthfully to present in the editorial columns what cannot fail to serve the interests involved; and in regard to the advertising section we feel and know that those firms who have availed themselves of our space will receive a publicity commensurate with their enterprise.

T. F.

The World's ELECTRIC PROGRESS

Editorial Commentary of the Month.

The Exhibition Supplement.

OUR treatment of the exhibits at the Olympia Electrical Exhibition has been undertaken on our usual classified lines and will be found complete in almost every detail. That the Exhibition was never intended to be representative of electrical engineering progress as a whole we have already recognised, and for this reason have prepared our record of it in semi-technical language with a view to making the description readable to the ordinary layman. Until the next Exhibition—for there will certainly be another on an equally ambitious scale at no distant date—the Supplement will be found handy as a document for commercial reference because it focuses attention on so many products of the chief British electrical firms. We say this in a broad sense, for we recognise that in the period intervening there will be numerous and striking improvements in electrical apparatus of all kinds. The bold display made by apparatus of this kind at Olympia has, however, certainly set in motion a public indifferent, curious, or unsympathetic towards electricity and its uses; and if this does nothing but stimulate trade in articles now standardised, the Exhibition will have fully justified the purposes prompting it.

Our Stand at Olympia.

OUR stand at Olympia was generally acknowledged to be notable among those of the electrical journals in many respects. Although we did not have a *salon* and a well-filled wine, spirit, and cigar cupboard, or exhibit anything in connection with electrical literature beyond our own production, we received the attentions of hundreds of electrical engineers, British, foreign, and Colonial, and others interested in electrical work, and we are gratified to find, as we feel our supporters will be, that our subscription list has been materially increased by the addition of names from all parts of the world. The sphere of usefulness of this journal was generally acknowledged, and the advertisement pages of the present issue will testify to the confidence and esteem in which the paper is held. We have to acknowledge the courtesy and enterprise of those firms who co-operated in making our stand what was conceded to be the most artistic of any technical journal in the Exhibition—to the Simplex Steel Conduit Co., Ltd., for their admirable wiring arrangements, to the Robertson Lamp Co., Ltd., for beautifully diffused light, and to Falk, Stadelmann and Co., Ltd., for the magnificent figures which adorned the corners of the stand. The lampholder fan, as supplied by the Beam Company, attracted attention, though if the weather had been warmer it would have developed its utility more. The most distinct novelty at our exhibit, however, was the sign portraying the heading of the magazine in ever-changing colours, made by the Chameleon Signs Company, Ltd. Altogether we were proud of our exhibit, and intensely satisfied with the result despite the special work involved, which has taxed our staff to the utmost.

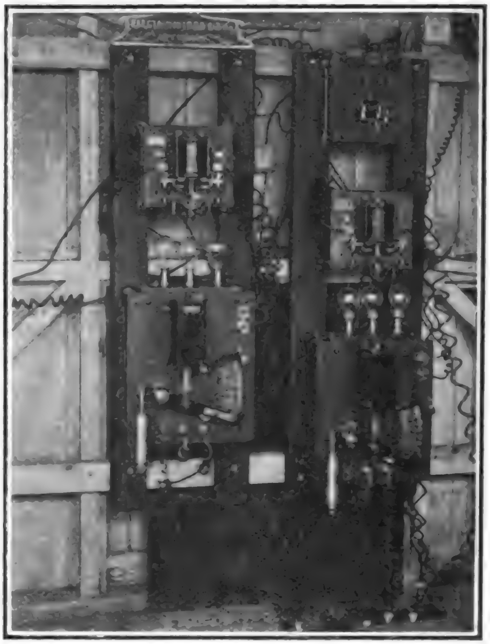
Liège and After.

IN face of the success of the Olympia Exhibition, what can be said of the enterprise (*sic*) of British manufacturers at Liège? With redoubled force the meagre representation of this country at the great Belgian exhibition now comes home to us. A short time before the opening of the Olympia show we were enabled, by the courtesy of M. Defrance, of the Belgian State Railways, to have a free inspection at Liège, and it "gave us furiously to think." The catalogue modestly states that the British exhibits, "although not so numerous as the magnitude of British and foreign commerce would justify, are of a high quality." This goes without saying when the names of such firms as Armstrong, Whitworth

and Company, Thos Robinson and Son, Ltd., Alfred Herbert, Ltd., W. and T. Avery, Ltd., E. Green and Son, Ltd., are concerned. These were, however, practically the only firms of note showing in the vast machinery hall—only these firms represented England's greatness in the engineering world! The industrial section — small and unrepresentative—contained the exhibits of a few chemical, fire-clay, glass, and other firms of this nature. We draw the curtain on Liège as far as the enterprise of British manufacturers is concerned, with the feeling that Germany, France, and other nations have immensely improved their industrial positions by virtue of the magnificent demonstration of their products. We have a feeling of the liveliest gratification at the manner in which the courteous M. Defrance, of the Belgian State Railways, placed the service of the magnificent system which he has the honour to represent at our disposal.

On Kingsway.

THE opening of Kingsway and Aldwych by their Majesties the King and Queen on October 18th forged another link in the great chain of London's traffic. In addition to the great expanse of roadway—100ft.—which in itself will form an important traffic artery, there will be run below road level a constant service of trams connecting North London with the Strand and the Embankment. This, when completed, will form London's first shallow tramway system, and will, if the Embankment section of trams is sanctioned, be the main connection between North and South London. It is interesting to note that the gates across Kingsway were opened electrically by the King, and the motor and control apparatus used is depicted on this page. A pair of simple motor winches were used and controlled by solenoid switches and rheostats fixed in the pavilion. As soon as the King turned the key in the golden ball placed before him, the magnet switches brought the motors up to speed, and by steel ropes drew the gates across the road. At the extreme limit of their travel the gates closed a relay circuit which switched current off the two motors. The motors were supplied by Electromotors, Ltd., and the control gear by the Sturtevant Engineering Company, and the entire apparatus was taken to Olympia to form an attraction to mystified crowds.



SOLENOID SWITCHES AND CONTROLLERS USED FOR THE MOTORS OPENING THE GATES OF KINGSWAY.

ONE OF THE MOTORS USED TO OPEN THE GATES ON KINGSWAY.

MR. FLESCH DE NORDWALL, DIRECTOR OF THE ENGLISH HOUSE OF THE ALLGEMEINE ELEKTRIZITÄTS GESELLSCHAFT.
Mr. de Nordwall gives his views in this issue regarding the causes of the Berlin electrical strike.

The Berlin Strike.

ONE short month has served to afford our German neighbours the spectacle of a great electrical strike. It is worthy of note that it required a nine months' conflict between masters and men to break the back of the engineers' strike in this country of 1897-98; but so are nations' workers differently constituted. We have taken occasion to interview Mr. Flesch de Nordwall, representing the Berlin A.E.G. in this country, to ascertain the causes underlying the recent agitation. He assures us that the wages of both the skilled mechanic and the labourer in the shops of the great German electrical companies compare favourably with those prevailing over here, and that the skilled hands were entirely averse to anything approaching a disturbance. He repudiates the widely circulated statements attributing the strike to low wages and bad treatment of the workers, and expresses the opinion that the movement terminating in the lock-out of the men was primarily due to the Socialist organ *Vorwärts*. This journal, which voices the sentiments of the great Socialist party in Germany, desired to coerce the electrical companies through the medium of their workmen, and being unable to influence the well-paid skilled hands, succeeded in arousing the labouring element to presenting exorbitant demands, which resulted in the strike. The skilled hands left in sympathy, and, as is now known, some 50,000 workers speedily suspended operations, partly out of regard for their fellows and partly by the compulsion of their employers. Mr. de Nordwall gave us an emphatic denial of any approach at arbitrary action by his company, contending, and we think rightly, that their excellent relations with the employees, and also the abrupt cessation of hostilities, are

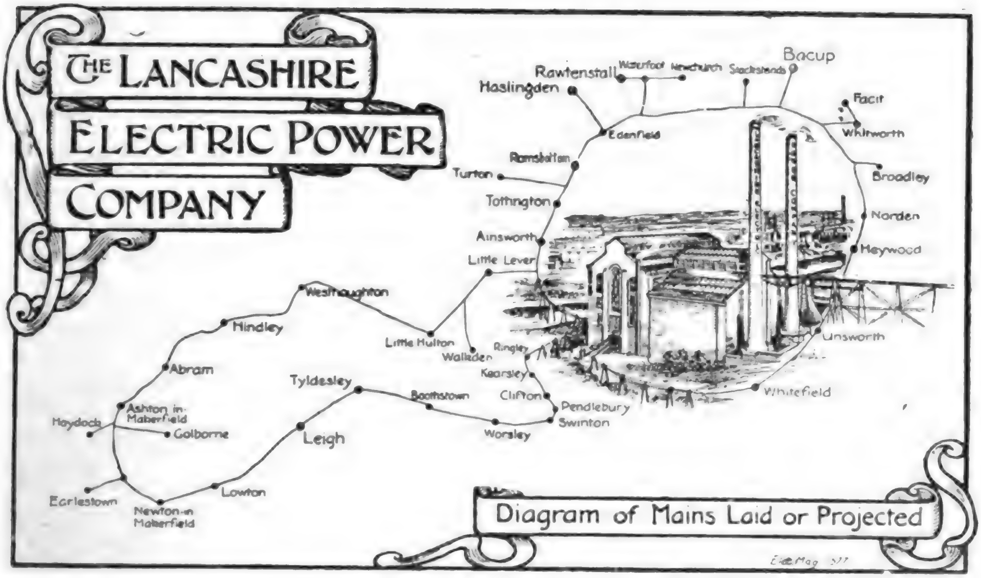
substantial testimonies to the ill-advised, not to say unscrupulous, attack upon German electrical enterprise by the Socialist party. It is inconceivable that so large a body of workers should so readily abandon claims which in many other cases have been fiercely and bitterly contested, without any other reason than that of necessity. We are glad to have complete confirmation from one in authority of our former high opinion of the commercial and industrial conduct of German electrical manufacturing as represented by the great companies now guiding electrical destinies in the Fatherland. Our readers will, we are convinced, join us in congratulating our neighbours on the speedy and satisfactory termination of what might have proved a disastrous blow to their progress in an industry of whose annals and reputation we are all justly proud.

G.P.O. Olympia Exhibit.

DISAPPOINTING must be the verdict pronounced on the collection presented to the public at the G.P.O. stand in the gallery of the great Exposition at Olympia; and when compared with others, such as the National Telephone Company and some of the older firms of electrical engineers, it suffered still more by the contrast. Neither in its historical nor in its modern sections did it attain to the reasonable expectations of an exhibition-visiting public. In the former, it was deplorably lacking in apparatus of absorbing historical interest, and it does appear passing strange that in a British collection of historical apparatus there should be no specimen of the Bain recorder or any of the many other inventions of that famous electrician! In the descriptive notice of the exhibits it is stated that Professor Wheatstone introduced automatic telegraphy in 1859, whereas, in reality, it was introduced by Bain in 1846. Historically the most interesting exhibits were Cooke and Wheatstone's four-needle instrument, dated 1838, when practical telegraphy was but a year old, and Highton's single-needle instrument, dated 1848. A much revered double-needle instrument from Buckingham Palace, bearing date 1851, the year of the laying of the first Dover-Calais cable and the birth year of submarine telegraphy, raised thoughts in the mind as to the many State secrets which must have flashed across its now begrimed face when Lord John Russell and Lord Palmerston were the chief advisers of the late Queen. Bright's bell and Varley's relay brought back memories of the old Company days, of their eminent engineers, and of the indefatigable pioneers of telegraphy. Who among the older plugs has not a warm corner in his heart for the dear old bell of Bright, and who but feel a pang of regret when he reflects that such a beautifully simple instrument should have been superseded by the crude double plate sounder? The Morse embosser was contemporaneous with the

INTERIOR OF POWER HOUSE, LANCASHIRE ELECTRIC POWER COMPANY.
THREE CURTIS TURBO-GENERATORS.

bell, the former being used by the Electric, and the latter by the Magnetic, Telegraph Company. Bain's chemical recorder was supplanted by the embosser in 1853, and seven years later the embosser gave way to the bottle inkwriter of Siemens and Halske. With the exception of the Bain, all these types were on view, which completes "the evolution of the Morse system" down to the simple sounder, the home of which is to be found in America. The only other instrument shown was an air-driven Hughes' type-printer, an instrument universally favoured in every European country except our own,



Facsimile of Cover of Souvenir Presented at Opening of Lancashire Electric Power Company's Station.

where it has only been introduced by absolute necessity on Continental cable circuits, notwithstanding the fact that it has stood the test of every country for long over three decades!

Electric Power for Lancashire. Despite the fact that the Bill authorising the operations of the Lancashire Electric Power Company was the first of its kind to receive the Royal Assent in 1900, the first station has only recently been opened and put into service. It must be admitted that in the matter of power plant design nothing has been lost in the interim, though with the generating sets common to practice of four years ago, a substantial load could have been handled, and doubtless something of the initial outlay wiped off. As it is the company starts right up to date with its equipment of large capacity vertical turbines, its compact station, and its pioneer stretches of overhead high-tension lines. In many respects the installation resembles that of the Yorkshire Electric Power Company, but with this important difference — and one which has everything to commend it—the high-tension mains are taken direct into the buildings of large consumers, and no intermediate conversion involving additional transformers has been attempted. Supply commences with many good consumers on the list, among these being a 75,000 spindle cotton mill, an iron works, and a slipper factory. From the send-off given the works by the Earl of Derby, and under the auspicious management of Mr. R. L. Gamlen, the undertaking should find prosperity at no distant date. We like the thought expressed in the last paragraph of the souvenir commemorating the inauguration, and reproduce it in full for its prophetic tone:

"With cheap power available in the rural districts, land, which would otherwise have been impossible, will now be available for manufacturing purposes. Manufacturers are not likely to be slow to take advantage of this cheap land in low-rated districts, especially as the motor wagon has now annihilated distance. Shall we see then the re-population of the country districts, and the solution of the question of the overcrowding of the towns? As in America, so here, there is already a tendency for manufacturers to put their works near the power. Shall we see new manufacturing areas springing up along the routes of the power mains, thriving under the most modern and efficient conditions? It may be that this day marks an epoch in the history of this Industrial Lancashire of ours. Time will show."

THE WINDMILL.—VIII.

Operated by DON QUIXOTE.

The Olympic Games.

Having heard that there were to be games at Olympia, I got a free ticket and went as a first-nighter. I was not conspicuous in the opening ceremony, being neither a civic orator nor, I fear, a civil engineer. I came later in the evening: likewise I saw, I wondered. But having waded through the literature on the subject which has since appeared, as well as the authorised and revised versions of the catalogue (whose three phase damsels on the cover have captivated me), I have arrived at the opinion that the things I should have seen and did not would afford much matter for high-class literary comment, whereas I came across many things which, not being on the bills, caused me to meditate.

For example, there was a man from the Far North who was making a little side-show of himself, explaining what he thought of the means of locomotion in London. He had apparently been cast up at King's Cross, a stranger to be taken in, with a dim idea that he had to go Underground to get to Olympia. He had been so long underground that his eyes blinked when he came into the Exhibition. He affirmed that this was not a testimonial to the lighting of Olympia (though he admitted the arcs were very inflamed), but to the Underground. He had met three porters and quite a number of grille-manipulators, each with a different theory as to the route to Olympia, with the result that after getting to Sloane Square and trekking from thence by variously coloured trains (some with spook-operated doors that playfully tried to pinch him) he took a 'bus at Earl's Court and arrived with the opinion that the Report of the Royal Commission on London Traffic was tame and inexpressive.

Moreover I ran up against a man whom I had known in the days when we were both younger and better. And his language had developed chromatic and kaleidoscopic properties which put to naught the display of Chameleon signs. I gathered from his somewhat discursive remarks that he had been hard at work for fourteen hours (which is distasteful to any man) getting things into shape for the opening: that he had breakfasted at twelve and lunched off a dry biscuit: that no packing cases were allowed inside the Exhibition, compelling him to unlimber somewhere in the environs of London and personally conduct all his goods to the stall: and that quite an excruciatingly small number of hours before the opening of the show those in the seats of the mighty had commanded him to take down all his waterproof, fireproof, fool-proof, devil-proof patent non-return interlocked automatic switches and hedge them with fireproof material. And as a manufacturer he stated an opinion (with which I totally disagree) that the consulting engineer is Albion's knell.

Somewhere near the place where they were developing extra-sec ozone with a furious odour, I came across a ghastly sight. The countenances of all who passed by turned livid; their lips became almost black; the very air seemed blue, not through the usual causes. And as the gentleman in charge of the stand which produced these alarming effects stood vertically beneath his lamp to explain that there had been added an ordinary incandescent filament to minimise the violet violence, the cheerful glow from the aforesaid spiral played gently on the summit of his nose, imparting thereto a colour effect which gave rise to much inductive reasoning.

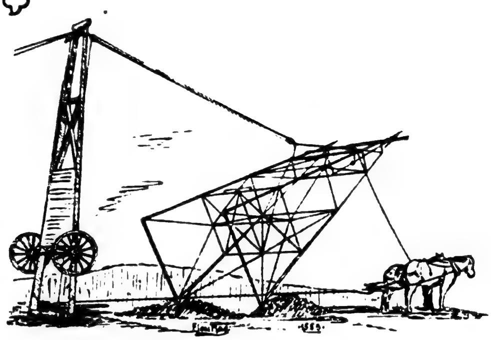
In my search after the good and beautiful, I thought I had discovered a working model of a harem. But as I approached to fecilitate the pasha-in-charge, whose urbane countenance evidenced most lively satisfaction, I found that I was being shown how impossible it was for me to make a glow lamp. Judging from the crowd of devotees around these groups, I deduced that the light-blue girls and the dark-blue girls were the Goddesses of Olympia.

There was a statue in the centre of the hall, a colossal figure, high and mighty and lifted up, bearing aloft the electric flame in strong, triumphant grasp. Its name was Victory, and it typified the power, the progress, pomp, and circumstance of Electricity. But was I unduly influenced, or is it really true that on this opening night of triumph the victorious flame was not alight?

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Steel Towers v. Wooden Poles for Transmission Circuits.

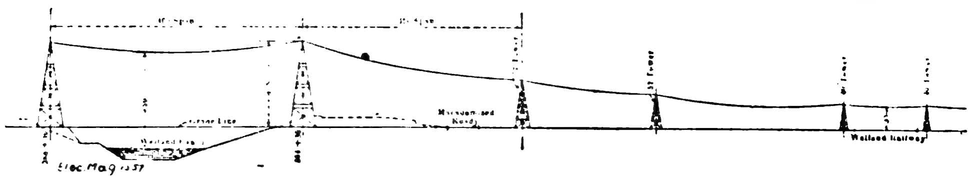
THE wooden pole has done yeoman service for transmission line work, and to-day is supporting many more tons of wire carrying high voltage currents than is the steel tower. The latter has, in fact, been regarded with some suspicion until recent years, and in the past has only been employed for such special service as crossing rivers, narrow canyons, gorges, &c. Both in America and on the Continent, and in fact wherever hydro-electric transmission lines are in operation, mixed feelings exist as to the respective merits of these two distinct classes of support. The subject has been much discussed before engineering societies, but



METHOD OF ERECTING LARGE TRANSMISSION TOWER.

we do not recall so complete a comparison of the two methods as that made by Mr. A. D. Adams in an article contributed to the *Electrical Review* of New York. From that source we have prepared the illustrations which accompany this abstract, and as there is likely to be a wider use of overhead leads in this country, the figures given should prove permanently valuable. A number of instances are given of power plants operating with steel towers and wood poles, and for easy reference we have tabulated these.

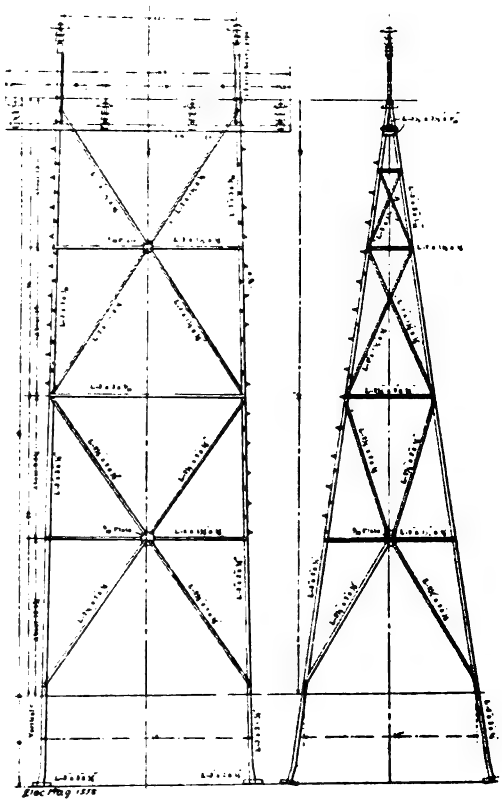
SYSTEM.	Length. Miles.	Support.	Power Transmitted.	Voltage.	Time in Use.
Niagara, Toronto	75	Steel Towers	40,000 h.p.	60,000	Nearing completion.
Guanajuato, Mexico	100	Steel Towers	3,300 ,,	6,000	Twelve months.
Electra, California	147	Poles	13,000 ,,	60,000	Six years.
Colgate, Oakland	142	Poles	15,000 ,,	6,000	Six years.
Cañon Ferry, Missouri	65	Poles	10,000 ,,	55,000	——
Shawinigan, Montreal	83	Poles	6,000 ,,	60,000	Four years.
Niagara, Buffalo	26	Poles	30,000 ,,	22,000	Eight years.
Gromo-Nembro (Italy)	20	Poles	4,000 ,,	40,000	Twelve months.



The Niagara Toronto Line at the Crossing of the Welland Canal.

They do not, of course, represent the total of the world's power plants, but typical extra high voltage systems, chiefly in America. Mr. Adams' chief figures relate to the cost of steel towers and wood poles, and for a fair average line with leads 25ft. to 30ft. above ground a steel tower will cost five to twenty times as much as a wood pole (in U.S.A. and Canada). That is not, of course, all the story. All things considered, it is estimated that on the ground of first and last cost the steel tower will be less expensive than the wood pole. At present market prices, steel towers can be obtained from 3-3½ cents per lb., and, further, the cost of a steel pole will vary nearly as its weight. Foi example, a 45ft. pole to carry a pair of 11,000 volt three phase lines would have cost $80 last year. The towers installed on the Guanajuato line in Mexico were built up of 3in. by 3in. by $\frac{3}{16}$in. angles for the legs, stayed with rods and ties of smaller section. Each tower has four legs, which meet near the top 40ft. above ground. Each tower weighed 1,550lb., and carries a single three phase circuit, comprising cables weighing 1,340lb. per mile. At 3 cents per pound these towers would cost some $45. A set of typical steel towers was erected for the Chambley-Montreal line over the Quebec Canal in 1902, there being four 144ft. towers. These towers were erected on site for $4,670, and as they weighed something like 121,000lb., their cost erected was about 3.86 cents per pound.

For wood poles of cedar, a fair average price is $5 each for 30ft. poles with 8in. tops, and fitted with one or two cross arms. This figure includes delivery over the greater part of the United States and Canada. The price given does not include erection. An average span for 35ft. poles is 100ft., but this is frequently exceeded, on straight runs especially. On the later line between Niagara and Buffalo, poles are placed 140ft. apart. With towers, the spans can be, and are, extended to 400ft., so that one tower will replace four poles. But the cost for poles is not thus excessive, as figures show; at $5 a pole, four poles cost $20, but $45 is needed for one tower, and in certain cases as much as $84. The poles, however, only carry one circuit and the towers two, so that, to equalise matters, the cost of the poles must be raised by $20. Another item is the insulator and its supporting pin. With poles many more are required than with towers, four times, in fact. Taking a 60,000 insulator and pin to cost $1.50, the saving per tower comes to $13.50, not a very considerable sum. In the cost of erection, despite the more numerous



Steel Towers for the Niagara Falls and Toronto Transmission Line.

poles, the tower saves little if anything, as concrete footings are needed, and the spans between are heavier to handle.

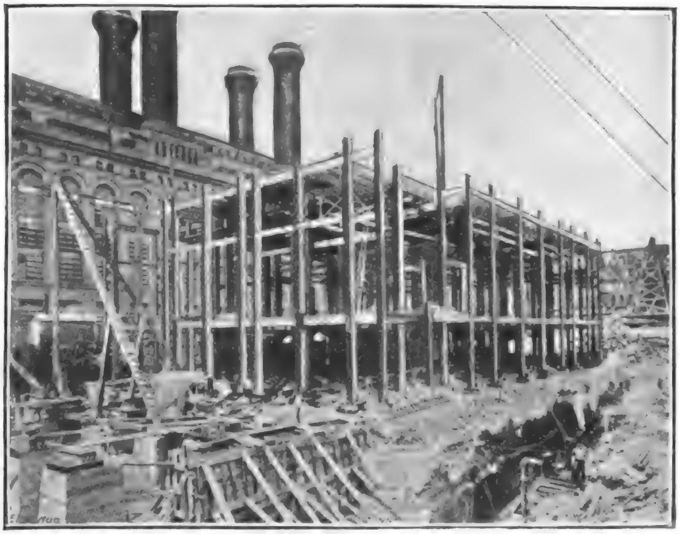
All things taken into account, the steel tower will cost from 1.5 to twice as much as the wood pole for a complete line supporting the same number of conductors.

A New Waterside Station.

THE New York Edison Company, when planning its now famous Waterside Station of 64,000kw. capacity, and even at its completion in 1901, considered that this mammoth plant would furnish energy for many years to come to the growing network of New York. Within three years it was, however, found necessary to make provision for additional plant, as the original station would be inadequate for the increasing demand within twelve months. We referred briefly to this project in our American Tour issue, stating at the time that a decision had not been reached as to whether turbines or reciprocating engines or both should be installed. Ultimately it was decided that both horizontal and vertical type turbines should be employed, and the plans for the plant were got out accordingly. The methods of constructing turbo-generators had been brought to such a pitch of perfection that the remaining five vacant foundations in the original Waterside plant were also filled with Curtis turbine units instead of the tower-like engines and massive generators making up the other eleven units. We give illustrations of the new building and a plan and section of the engine room and switch galleries. These are taken from the *Electrical World and Engineer*, which we may quote in regard to the building and its equipment.

"The boiler-room section consists of a 20ft. basement, one 36ft. and one 34ft. storey for the boilers, and above this a space of 50ft. up to the general roof level, which is devoted to the coal storage bunkers; the coal-handling system will be accommodated in the roof monitors. The turbine section involves a 25ft. basement for condenser apparatus and a main turbine-room with a clear height under roof trusses of 88ft. The group of side galleries at the 40th Street side of this room consists of six mezzanine galleries above the main floor for the electrical switching equipment, and a basement gallery for a substation and reserve exciter storage-battery equipment.

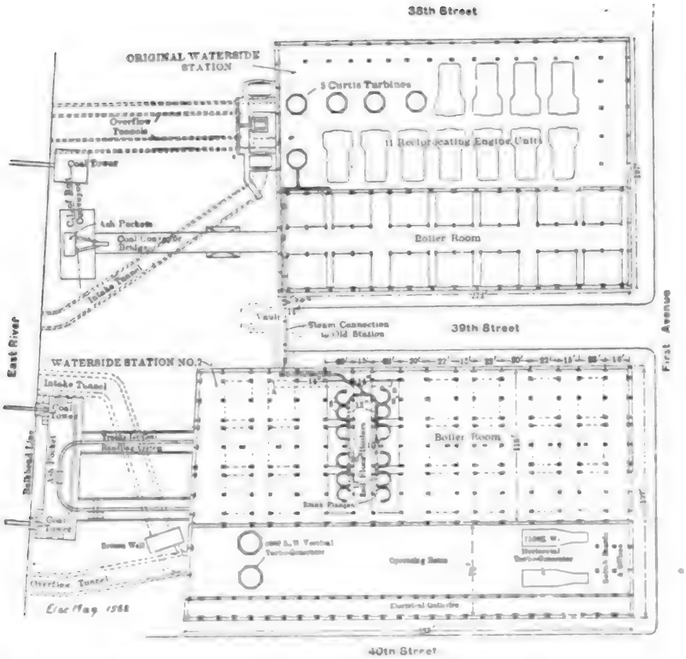
"The power house building is of steel frame and brick and concrete construction, forming an absolutely fire-proof structure throughout.



STEEL CONSTRUCTION OF THE NEW WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.
The station will ultimately deliver 100,000kw. to greater New York. The old station is in the background.

The boiler-room and turbine-room floors are of very heavy construction, designed for uniform loadings up to 600lb. per square foot; the floors are all of concrete upon the Roebling system. In addition the structure carries, on the boiler-room side, five large anthracite coal bins to hold a total of 20,000 tons, when all are filled. The coal bins are of reinforced concrete construction with vertical stiffeners of I-beams embedded at intervals.

"The station has been laid out to accommodate ultimately ten steam turbine generating units of 7,500 or 8,000kw. capacity each, giving thus a total station capacity of over 100,000h.p., or, with 50 per cent. over-



Plan of New and Old Waterside Stations of New York Edison Company.

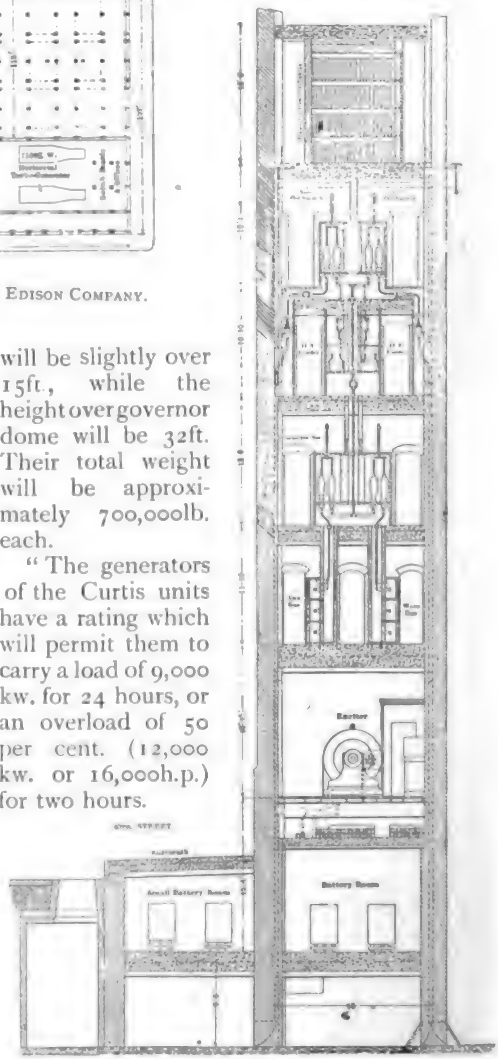
load rating, of over 150,000h.p. At first, however, only four turbines will be installed; two of these to be of the Westinghouse-Parsons type, and the other two of the General Electric Curtis type.

"The new 7,500kw. Westinghouse turbine units will differ little from their well-known 5,000kw. machines, the same general type and form of unit being preserved in the new design. It will be 50ft. long, 17ft. wide, and 15 t. high, occupying thus a total floor space of 850sq. ft., or 0.113sq. ft. per kilowatt capacity. It will thus be only about 4ft. longer than the 5,000kw. turbine unit, while the width will remain practically the same. These turbines will operate at 175lb. pressure and 100° of superheat, and the speed will be normally 750 revolutions per minute. Under the above conditions and a vacuum of 28in., the steam consumption at full load will be approximately 16lb. per kw.-hour.

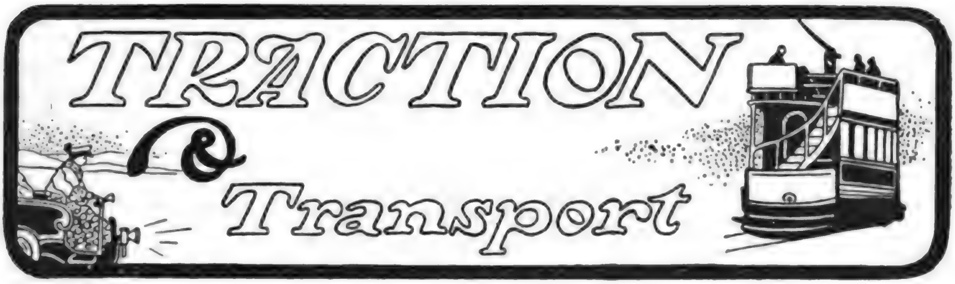
"The turbo-generators connected to the Parsons type turbines will embody a new enclosed construction which will be effective in entirely eliminating the hum peculiar to high-speed turbine generators. The stationary armatures will consist of a cast-iron frame with laminated core and coils set in partially closed slots; the field cores will be built up of steel castings, with slots milled in the poles to receive the windings, the coils being formed by s raps wound flat in the slots and the slots closed by brass wedges.

"The two Curtis turbo-generators by the General Electric Company will have normal ratings of 8,000kw. with 50 per cent. overload capacity for two hours. Their diameter at the base will be slightly over 15ft., while the height over governor dome will be 32ft. Their total weight will be approximately 700,000lb. each.

"The generators of the Curtis units have a rating which will permit them to carry a load of 9,000 kw. for 24 hours, or an overload of 50 per cent. (12,000 kw. or 16,000h.p.) for two hours.

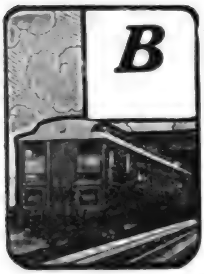


View of Electrical Control Equipment. New Waterside Station.



A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

Electric Traction for Mail Transportation.



BOTH the high speeds and simple equipment which characterise electric traction apparatus admirably fit it for such work as the transportation of parcels and mails over specially-constructed tracks. Present-day methods of handling the mails, by special trains having sorting, delivery, and collecting cars, could certainly be improved upon were the work of transporting undertaken separately. In the first place, larger premises and improved sorting arrangements would facilitate this portion of the operations, and, secondly, the mails and parcels once sorted could be dispatched with complete safety at much higher speeds. Velocities almost treble those now prevailing with trains could be attained, and as neither life nor limb would be risked, the factor limiting the speed would rest with the system employed and its operation in practice. A society was formed some time ago in France to investigate the possibilities of electric traction in this province, and an experimental track was laid down for testing a high-speed car. The track was circular, of 500 mètres radius, and built of square wood frames to form a structure such as is shown in Fig. 1. Owing to lack of funds, it was necessary to conduct the experiment on economical lines, and for this reason the circular track was decided upon. The minimum speed desired was 250 kilomètres per hour, or 70 mètres per second, and the structure

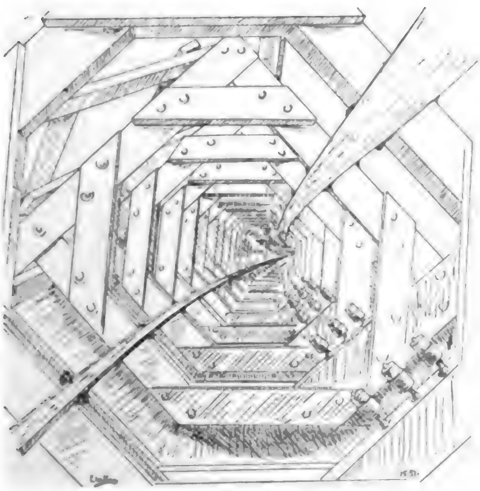


Fig. 1. Running Rails and Structure for Electric Postal Service.

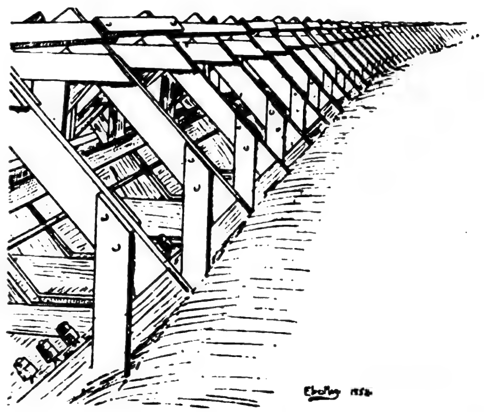


Fig. 2. Exterior of Special Structure for Electric Postal Service.

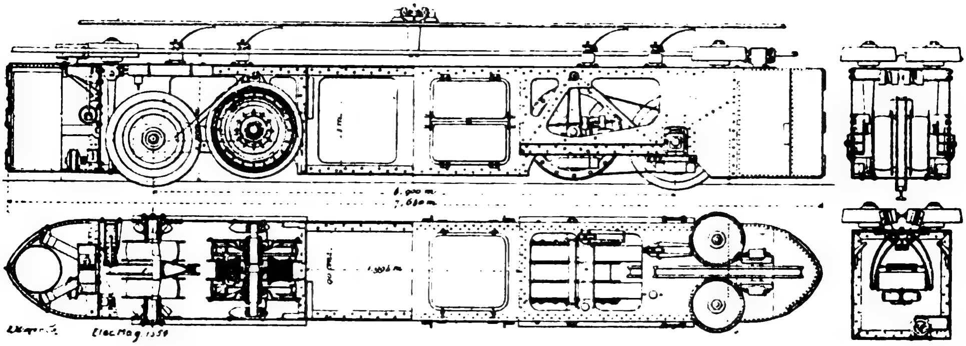


Fig. 3. Electric Postal Car, as Experimented with in France.

referred to was adopted to prevent overturning on curves; in fact, it presented the only alternative to a tube for high speeds.

Fig. 2 illustrates the exterior of the structure and shows the setting of the frames in a cutting in the ground. It will be noticed in Fig. 1 that the running rail is attached to one of the inclined sides of the frames, and a guide or steady rail is fixed at an opposite point of the structure. At a point lower down the three working conductors are fixed on insulators.

The car has been specially designed to travel at high speeds, and runs on two grooved wheels back and front. Fig. 3 depicts the arrangement and shows the driving gear both back and front. The guide wheels are conical rollers with vertical spindles, the rollers pressing on each side of the guide rail being held in contact by springs. Polyphase induction motors furnish the requisite power, there being two motors fore and aft. They are of the four-pole type and are supplied at 1,000 volts with three phase 25 cycle current. To get the necessary speed the motors are geared up by leather belts to the driving axles, each motor having two belts, which are kept taut by a spring. The method of placing the motors and arranging the drive is clearly illustrated in Fig. 3. From this illustration the compartment system adopted on the car will be evident. Both ends have two sections each, for the driving and oiling arrangements respectively. The centre portion is reserved for the mails. The oiling system is very complete, a small direct current motor operated from an accumulator being employed to drive a three-throw pump for maintaining the oil pressure. Should braking appliances be found necessary they will also be placed in the end sections. Fig. 4 shows the motor suspension and the belt drive, together with the tension spring for the belts. The total length of the car is 7.6 mètres, the height 1 mètre, and the width 90 centimètres. The running wheel centres are 4.9 mètres apart, and the total useful load is 500 kilogrammes.

Particulars of this scheme were recently published in our French contemporary *L'Industrie Electrique*, but we regret that no figures of the results were given, nor were data supplied as to the power required or speeds attained. The fact that the matter is under consideration points to possible activities in this direction, and as it is but another instance in which electrical energy can be efficiently and serviceably employed, we hope some practical issue will result from further investigations. Between distant centres like London, Manchester, Glasgow, Birmingham, Plymouth, and in fact the greatest towns and cities of the kingdom, some express postal service could be run by electrical means, and when a sufficiently cheap and safe structure can be devised the application

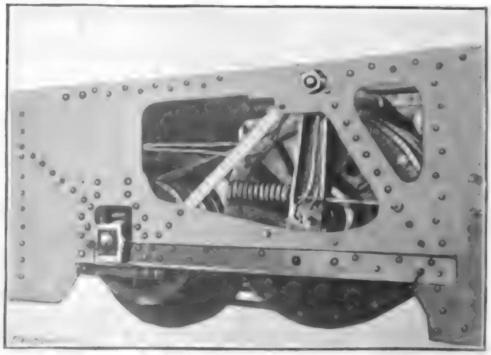
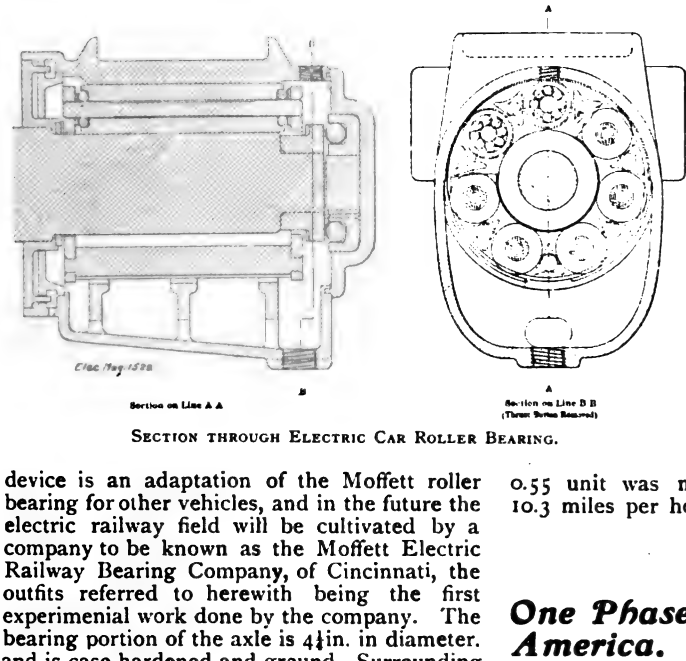


Fig. 4. Driving Motor and Gear of Electric Postal Car.

of a high-speed car would not be difficult of accomplishment. A tube naturally suggests itself, but in direct opposition an overhead structure seems equally feasible. Whether of the twain could be standardised only exhaustive experiment can show.

Roller Bearings for Cars.

THE subject of roller bearings for tramcars has received constant attention for years past, and they bid fair to prove reliable in practice. Experiments have been made on a new electric railway in Toledo, U.S.A, and we append some particulars of these taken from the *Street Railway Journal.* "On several of its cars the company has been experimenting with roller bearing axles, and is so pleased with the results that it will adopt them on all cars. The



SECTION THROUGH ELECTRIC CAR ROLLER BEARING.

device is an adaptation of the Moffett roller bearing for other vehicles, and in the future the electric railway field will be cultivated by a company to be known as the Moffett Electric Railway Bearing Company, of Cincinnati, the outfits referred to herewith being the first experimenial work done by the company. The bearing portion of the axle is 4¼in. in diameter. and is case-hardened and ground. Surrounding it are seven solid steel rollers. They are kept apart by separators and have rows of balls at either end to provide against the thrust. The rollers revolve in a casing which is case-hardened and ground, and the whole bearing is in an elliptical cast-steel box, which serves as an oil reservoir. The bearing is oil-tight and practically dust-proof. In practical tests, the company used two cars identical in every item of equipment, except that one had plain bearings while the other had roller bearings. An accurate record of current consumption was taken at frequent intervals, and between March 23rd and May 6th, 1905, each car covered 10,000 miles. The plain bearing car consumed 3.62kw.-hours per car-mile, while the one with the roller bearing used 3.01kw.-hours per car-mile. The bearing showed no perceptible signs of wear and required no attention or re-oiling. With a saving of 12 per cent. in power consumption at the car, the engineer figures that it represents a saving of 18 per cent. to 20 per cent. at the power station, and with current at 1 per cent. per kw.-hour, that the saving of something like $2 per car per day, or $750 per car per year.

The same subject was treated by Mr. T. W. How in a paper before the British Association in South Africa. In the design of a roller bearing he regarded first cost as of secondary importance and practically subservient to the results in economy of power, lubricating oil, and coal. On line shafting in a London factory it was found that with plain bearings the driving motor required 8amps. running the shaft light, and 7amps. under the same conditions with roller bearings. With the machines connected, however, a nett saving of 24.4 per cent. was noticeable when ball bearings were used. For tramways such bearings are specially suited, and as early as 1898 some tests in Birmingham showed a saving of 24.30 per cent. per ton of load, or 1.035 units per mile run, equivalent to £38 16s. 3d. per car per year. At Southport more recent tests showed that whereas one unit per car-mile was required with roller bearings for a mean speed of 8.6 miles per hour, only 0.55 unit was needed for a mean speed of 10.3 miles per hour.

One Phase Traction in America.

WHEN the time comes for British railways to seriously consider one phase traction for main lines, a debt of gratitude will be due to American and Continental engineers for their zeal and enterprise in developing the system. The presence of the Ganz Company in the United States has not in any way chilled the ardour of the companies exploiting one phase lines, and judging by the recent meetings of the American Street Railway Association interest in this new field of traction is becoming keener. We shall refer in our next issue to the other papers presented to this Association this

annual session, but for the moment present the important and valuable deductions of Mr. C. F. Scott regarding the one phase motor for railway purposes. The wording of his paper in certain parts is so succinct that abstracting would damage its tone, so we append these portions in full.

"It is not the motor itself, but the single phase system which the motor makes possible that is of prime importance. And the system is of commercial value only as it is able to operate electric railway service more effectively and economically than is practicable by other means. The single phase system accomplishes the same results in car movement as may be obtained by direct current equipments, but in many cases with less first cost, less operating expense, increased flexibility, and greater simplicity."

"In how far have the advantages claimed for the single phase system been realised? Among the important features are the following:

"A high-voltage trolley construction has been developed and has proved to be simple, strong, and thoroughly practicable. Thirty-three hundred volts has been used and has proved to be safe and reliable.

"A sliding contact device which does not require reversing when the direction of the car is changed is found more satisfactory, especially for high-speed operation, than the trolley wheel. Its wearing surface lasts longer than trolley wheels operating lighter cars on direct current.

"Transformer substations supply current satisfactorily without feeders and without station attendants.

"The car equipments show simplicity and effectiveness in the control apparatus. Less than half the controller notches required for direct current give equally smooth and as rapid acceleration with alternating current. Platform controllers are simpler, as no magnetic blow-out is required. The multiple-unit control system is readily adapted for the operation of single phase motors, and is in some points simpler than the control of direct current motors.

"The operation interchangeably by alternating current and by direct current is a feature of an important road which operates large equipments on direct current in the city and on alternating current across country.

"Motors of four or five sizes have been built and show excellent commutating features. The commutators take a good polish. The motor windings are such that there is a practically balanced magnetic pull, even if the armature be slightly out of centre. Although the armature speed is higher than in corresponding direct current motors, the advanced criticism has proved ill founded, as there have been no bearing troubles. The oil lubrication has proved highly satisfactory.

The Field for One Phase Railways.

"The development of a new and more efficient method for accomplishing a given result often leads on and opens new fields which had not been commercially practicable before. Such is the case with the single phase railway. The direct current interurban railway has its limitations. If a region be sparsely settled the available traffic will not show a profit on the cost of circuits and rotary converter substations. There is a material reduction in the investment and operating expense incident to the single phase railway that will enable it to be built and operated with a profit in cases where the traffic would not support a rotary converter system.

"On the other hand, in heavy service the direct current has not made much headway, being handicapped by the heavy cost of substations and of conductors. Heavy and relatively infrequent trains are the hardest loads for substations. For example, if substations be eight miles apart, each will supply eight miles of track. A train running 40 miles per hour will receive current from a given substation for 12 minutes. In order that a substation may be continuously supplying current to trains in one direction they must have a headway of 12 minutes. If they be an hour apart the current from each substation is used but one-fifth of the time. Trains in two directions will double the substation output, but as the peak load is considerable when two trains pass near a substation the load factor is extremely low. Therefore as the aggregate capacity of the substations must be large in proportion to the actual power taken by the cars, it follows that the substations will involve a relatively large expense if they are equipped with expensive rotary converters and require constant attendance, whereas the cost will be relatively small if they require simply lowering transformers having an efficiency very much higher than the rotary converter substation and not requiring attendance. The reduction in the substation is therefore of especial value when the service is infrequent. Moreover, the single phase equipment by reducing the size of conductors frequently enables the substations to be more widely separated. This possibility in the reduction of the number of substations and in the aggregate capacity of substation equipment, and their attendants, makes practicable the operation of long-distance roads which could be operated by direct current only at an excessive cost.

"The single phase system therefore decreases the cost of installation and operation for interurban service by direct current, and it extends the field of commercial operation to include, on the one hand, rural roads with relatively light traffic, and on the other, a heavy, infrequent multiple unit or locomotive service for passengers or for freight approximating steam railway conditions."

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

Nernst Lamp Ballast and Glower.

IN the language of the Nernst lamp maker, the small iron wire resistance inserted with these lamps is termed the "ballast." From the point of view of the user of Nernst lamps the relations of this ballast to the glower are of little consequence, as his chief concern is with the light emitted from the lamp quite irrespective of the functions governing its radiance. The influence of the ballast on the glower is very great, and a close analysis of its operations reveals some interesting facts. Mr. L. A. Terven, in the columns of the *Electrical World and Engineer*, goes very closely into this relationship, and by the aid of curves graphically depicts its chief phases. Referring to the resistance he says:

"As is commonly known, the ballast used consists of a fine iron wire, sealed into a bulb containing hydrogen. The hydrogen not only prevents the iron from oxidising, but, on the other hand, it materially affects the molecular arrangement of the iron resistance, so that the curve between current and volts is found to be much steeper in a hydrogen atmosphere than it is under other conditions.

"Fig. 1 shows the normal ballast curve. It will be seen that the rise in resistance of the iron wire is quite rapid just above the point upon the curve where the lamp is normally operated. The ballast curve is usually plotted on the basis of percentage. This is the only fair way to show a ballast curve, but the current scale is extended in the curve shown, which makes the ballast curve appear flatter than it really is. The ballast is a very interesting piece of apparatus from quite a number of standpoints. The shape of the curve may be changed and one may get a different characteristic from the lamp by working at different points upon the curve. The selection of the proper quality of the iron to be used for wire is of very great importance."

The ballast is remarkable for its sensitiveness, but it can become sluggish through the specific heat of adjacent materials and also to interheating of parts. The glower also changes its characteristics with age, though

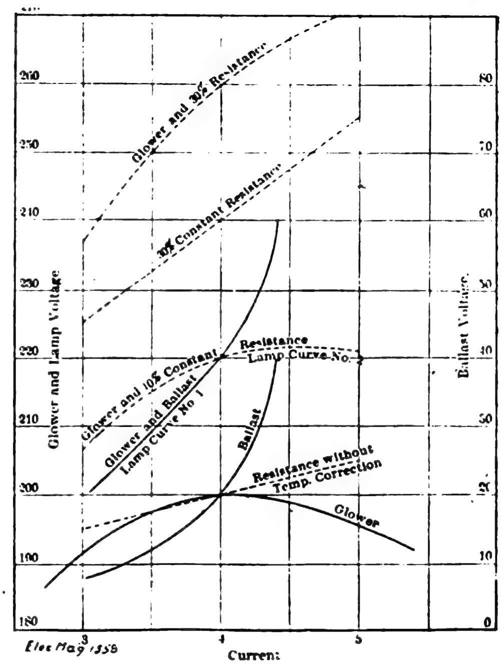


FIG. 1.

the point at which it operates at constant efficiency does not vary in its characteristic, or if it does, it is to assume a more stable position. Referring again to Fig. 1, to quote the author:

"Two lamp curves are shown taken from an aged glower; one of the curves is taken in connection with a normal ballast, while the other one is taken in connection with a straight resistance which consumes 20 volts at .4 ampere. Lamp curve No. 1 shows how a rise in voltage is easily taken care of by the ballast, while curve No. 2 shows a very unstable lamp, and a rise of 5 per cent. of the voltage would mean the destruction of the glower. If a simple

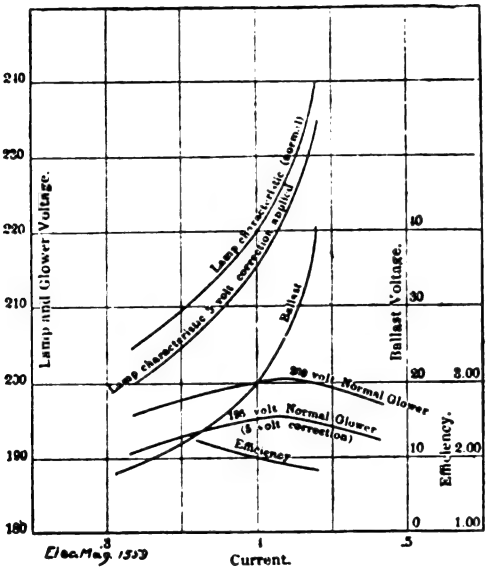


Fig. 2.

resistance is to be used as a ballast, the percentage of ballast would have to be increased from 10 to 30, in order to take care of the variation in line voltage, and even this 30 per cent. resistance does not accomplish the same result as the 10 per cent. iron ballast. One advantage of the ballast, which has no temperature coefficient, is due to the fact that the lamp is non-sluggish and the glower never gets an excess current, except that corresponding to an over-voltage circuit."

"The best way to learn how the ballast and the glower combine to make the lamp is to study curves illustrating different cases. Theoretically one has an innumerable variety of circumstances. For instance, the glower may be normal or it may be squirted for too low or too high an efficiency. The ballast with which these three glowers are combined may be a normal, an under-voltage, or an over-voltage ballast. Taken in this way, nine curves would result, but all of these are not necessary. In Fig. 2 the normal ballast curve is combined with the normal glower curve to produce the normal lamp characteristic. The lamp curve so shown is very stable, and the lamp will withstand a 10 per cent. excess of voltage for continuous service.

"The lamp will stand a temporary over-voltage of 20 per cent. without injury. On the same sheet (Fig. 2) a lamp curve is shown corresponding to a glower which is five volts lower sorted voltage than it should be. This corresponds to a method formerly used for so-called glower correction. During the early stages of the Nernst lamp development, and, in fact, up to 1903, glowers commonly had quite a rise in voltage during life. This amounts to from three to four volts per 100 hours on constant current. When such a glower is run in the lamp, during the first 100 hours it does increase in voltage by three volts, but afterwards, because of running at a higher current, caused by a rise in glower voltage, the rate of rise in voltage of the glower is very small, because the rise in voltage of the glower is a direct factor of the specific consumption at which the glower is operated."

"If a glower is exposed to the sun on a bright day, and it is attempted to make the light of the glower falling on a white screen equal in value to the light falling direct from the sun, it will be found that the glower must be operated at as low a consumption as 1.2 watts per candle-power. Under such circumstances a glower will not live very long. On the other hand, if one wishes to duplicate diffused daylight in a hall it can be easily done with glowers running at two watts per candle-power, but it must be remembered that if shades are put upon the glowers the tendency is to throw the spectrum down toward the red end. The diffused light in ordinary residences is duplicated almost exactly by the light received from Nernst lamps being opalescent balls absorbing about 16 per cent. of the light passing through them. Heavier balls usually give a yellowish effect to the light. Sand-blasted and etched balls do not play so much havoc with the colour value of the light."

For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

Telephone Exchange Equipment.

By A. L. STANTON, Student I.E.E.

(Students will read with interest the following abstract of an I.E.E. (Student's) paper on the subject of "Telephone Exchange Equipment." The easy style will render the matter readily assimilable.)

Power Plants.

As the power plant may be well termed the heart of a common battery system, it deserves the first attention. Such plant for telephone purposes has unique points, the voltage employed — twenty-four — being low. All vital parts, as charging and ringing machines, are duplicated, as are also the main batteries, in view of a breakdown. The eleven secondary cells made up to form a twenty-four volt battery for a large service have a heavy current capacity, hence generators for charging purposes have to be designed with a voltage output of certainly not less than thirty, whilst the ampere output may run into hundreds, an additional feature being that the windings have to be arranged, in view of emergency requiring machine to run on the system, to allow of such running without any fluctuations due to commutation under varying loads affecting the service. As in most large centres to-day electric supply is available at reasonable consumptive rates, motor generator combinations are in general utilised for charging purposes, with dynamotors for supplying an alternating ringing current of medium frequency, it being seldom, if ever, found that electric supply as available is primarily suitable for telephonic purposes. The motor for the former may either be direct or alternating current in character; and, as is well known, in a motor generator the latter pressure can be regulated quite independent of the motor, whereas in the dynamotor form of energy conversion that is not so, primary and secondary having set values.

In maintenance everything should be kept scrupulously clean, and great care taken that all controlling adjustments are correct. The positive sides of the twenty-four volt batteries are grounded common, the negative sides being controlled by a single pole change-over switch for service requirements. In this system, as adopted in London, owing to the requirements involved in connection with the working of private branch boards, external to the central exchange and yet supplied with current from the central, it necessitates the ringing current completing its circuit through the main battery. To effect this, one side of the ringing circuit is permanently grounded with the return connected to the main battery negative bus bar.

It is also interesting to note that in the case of the charging circuit, the generator charging battery being charged and battery on service, all have their positive poles to ground. This, coupled to the peculiar ringing circuit, renders it necessary to give special attention to the common ground connection and several other points outside the scope of this paper, otherwise some peculiar inductive faults make themselves apparent upon all the talking lines.

In some exchanges another battery is in

use for supplying service meters with energy, the voltage output for this purpose being thirty; in other exchanges, a direct current generator is used in the place of secondary cells for the same purpose. For good maintenance the battery room should have everything conducive to the attendant fulfilling his duties in a proper manner.

Charging generally is carried out by the "constant current" method, in which as charge proceeds the power required to continue increases accordingly. Sheets should be submitted, and a log book kept, giving in addition to the usual charging records daily voltage and density readings. These records often point out slight faults which, if given attention at the time, prevent more serious ones developing.

Fuse Distribution.

The distribution involved in these systems demands that special care be given to the power wiring details, otherwise cross talk and other inductive influences will be superimposed as it were upon the talking lines. From the main battery and ringing switches on power board, cable leads are run to a special cabinet, all wiring connections being made at the back, with its front as a fuse rack. From this point is distributed energy for all the various circuits, excepting the repeating coils, the fuses of which are placed on a special panel near repeating coil rack. Obviously, in a large exchange means have to be devised for economically controlling the most numerous circuits. This is effected as follows:—Each subscriber's position has 180 line lamps fitted, and if a fuse were inserted in every line for twenty such positions, this alone would mean 3,600 fuses. To obviate this, one fuse is fitted to control each position of 180 line lamps; similarly fuses are inserted to control each 100 line relays and each 100 line resistance lamps. In view of the fact that a fuse blown, controlling any particular group, practically breaks down the group, it is essential, in such an event, that the fuse be made good immediately, and steps taken to locate the cause. In the above three mentioned groups this difficulty is met by arranging the connections in such a manner that when one of the group fuses is blown it automatically closes an alarm bell circuit, thus instantly advising those in charge, the alarm circuit remaining closed until attention is given. All fuses controlling cord circuits and other plant on positions have also to be allocated in a manner that prevents any serious dislocation of apparatus should a controlling fuse blow.

Engaged Signals.

Primarily these signals are obtained by means of gearing on the ringing dynamotors, interrupters opening and closing special connections in these circuits, in connection with which, on the switchboard proper, are a row of jacks multiplied to every section, so that an operator can choose the required information signal. On a subscriber being plugged into one of these jacks, alternating currents by induction cause his receiver to emit a high toned hum at regular intervals; this denotes the "engaged" or "busy" back signal. If the tone is pitched at alternately long and short intervals, it indicates the "don't answer" signal.

Central Cable Details.

For dealing with the other equipment of exchange plant, I will assume the service system to be fed by underground cables—such cables are now manufactured which, both mechanically and electrically, prove their adaptability for feeding large congested districts. In this case the main distribution frame would probably be situate in the basement of exchange building. Such cables are known as dry core air space cables, the core conductors being insulated with paper, air also forming a part of the dielectric, the whole being sheathed in lead. As the "K.R." or static capacity and resistance, apart from self induction effects, are the limiting factors for speech transmission in copper conductors, the innovation of the above type of cable was an immense stride towards its solution, where cable work has to be considered, their static capacity being low, the advantage for congested areas being the economy of space offered in their make up. In the London Post Office system two gauges of copper conductor are employed, a 40lb. conductor for junction lines, resistance of 21.94ω per mile, and a 20lb. conductor for subscribers' lines, resistance of 43.98ω per mile. These cables at the exchange end are jointed to lead covered cables where the conductor dielectric is silk and cotton. These form the main frame connecting links, and care has to be taken to ease the weight entailed at the point of leaving cable ducts by supports, the section stripped of lead covering for lacing

purposes being, after the butt has been sealed with insulating compound, varnished with shellac or other insulating solution.

Where such cables are in use, an air compressor is fitted for the purpose of pumping dry air into them, should the insulation fall low. This is carried out at a pressure varying between 18lb. and 24lb., regulation being obtained by means of a valve. The pressure is of great value for proving that all-important item, common to this type of cable, the plumber's joints, and at distribution points, cable heads for being air-tight. Care has to be taken to test the main air pressure in order to prove whether it is dry air or not that is passing into the cables. Generally, a rack is arranged with taps for the various mains coming into connection with the main pipe in a manner that allows of pressure being cut off or on any required cable main. All air pressure obtained has to pass *en route* to cables through several cylinders containing calcium chloride, this substance absorbing moisture very rapidly; any atmospheric moisture present where machine is running is taken up until the calcium chloride is saturated, when it must be changed and renewed.

Wiring Details.

Proceeding to wiring details, the main distribution frame is the point where all external cables are first connected. This frame is open, constructed of iron work, on which are mounted as requirement demands hard wood blocks carrying insulated tabs.

The wiring arrangement is as follows:

On one side the blocks are fitted horizontally; to these are connected the external cable lacings. Twin cross connecting wires are now jumpered across to the other side blocks of frame; these are fitted vertical, and carry the central exchange protective devices, which merit a few remarks.

Protective elements in telephone work are three in number. First, to protect against lightning and other dangerous high potentials; this is obtained by a carbon protector, made up of two plates of carbon with a small disc of insulating material, generally mica, in between, having small spaces in it, allowing the carbon discs to nearly touch. One of these is permanently grounded, and any rapid high potentials, such as lightning discharges, tend, if conducted to this point, to take the path of the small air gap, separating the discs, as being of less resistance than the high impedance any apparatus in circuit beyond this point offers to this class of phenomena. It is also found that comparatively low potentials will break down this air space separating the discs and sparking across cause a fine dust to more or less ground the line connected, until the plates are restored to normal by cleaning the carbon surfaces. The second element is known as a heat coil, its object being to protect against low value currents, which may develop such a heat, if allowed to flow sufficient time, as would injure apparatus in circuit, yet will not be high enough in value to endanger the carrying conductor. The time such a low value current is flowing is the chief factor, as a dangerous heat may be allowed to slowly develop where no protection exists. There are various forms of heat coils, but the general principle is to arrange resistance in a manner that upon the passage of a current through it, heat is concentrated upon a core of soft fusible alloy solder, which secures the parts composing the heat coil. When a foreign current flows on the line, it has to pass through such a coil in series on each side, the core being made up to fuse at a certain value current, in general half an ampere in a given time; when this condition is fulfilled, heat is developed sufficient to melt the core, and the coils being between springs, held in the normal at a tension, the springs are automatically released, fly back, and in some cases complete a local alarm circuit, advising those in charge of occurrence, and disconnecting the circuit; in some other cases the operation permanently grounds the line side. The third element is a fuse. This, as is well known, is in all cases to protect the circuit connected to it from a current which is pre-determined as safe for conductors and apparatus in circuit to carry. In the system treated of this element is not fitted on the main frame, as are the other two mentioned, which are generally arranged in combination on the vertical side blocks, with connecting springs allowing of a double plug being inserted for testing purposes. In the maintenance of all distribution frames, great care should be taken that the wiring is carried out in a workmanlike and neat manner, particular attention being given to the insulation as the connection tabs are very close; probably in no other than common battery s stems is so much trouble experienced as is due to bad soldering, which

causes high resistance faults and bad insulation, giving rise to heavy leakage with its attendant evils. All cables should be distinctly marked on their respective position blocks and laid up in their proper pairs; if this is neglected for the talking lines induction will ensue. For horizontal side of main frame it is a good plan to have a code by which the cable wiring is known. Letters will be found suitable to form such a code, a log book being kept, giving the following details:—Street routes, pairs in cables, subscriber's number, if connected, and letter such a main or subroute is known as. When dealt with in any manner as above, it is clear that it greatly facilitates testing, and any necessary changes which, if needed to external cables, are, it will be evident, controlled from this frame. On the vertical side attention should be given during the initial wiring to the circuit requirements, as in addition to substation lines, outgoing order wires, incoming order wires, outgoing junction lines, incoming junction lines, and miscellaneous service lines may be required. It is obviously not uniform or good work to have all these different lines wired at haphazard, as occasion demands, on any part of the frame side, and in a London centre the junction lines alone may run into hundreds in number. Cables are now led up from this vertical side to a second frame, known as the intermediate distribution frame. Its object is to directly enable the work on switchboard sections to be equalised by grouping the lines to the best advantage efficient service demands.

It is similar in construction to the main frame without its protective devices, likewise it has a horizontal and vertical side, quad connecting wires forming the connecting link. Cables from the main frame are connected to the horizontal side tabs, as are also the multiple switchboard jack cables, whilst the vertical side controls the home answering jacks and line lamps on switchboard wiring.

Directed Wireless Telegraphy.

Early in July some experiments were conducted at Strasburg by Dr. Ferdinand Braun with a system of directed wireless telegraphy of his own invention. The results seem to him very promising, for he was able at will to direct the waves so as to actuate the receiver at the receiving station or not. Dr. Braun in several German journals discusses his experiments, and points out the probable usefulness of his developments. Since electric waves are governed by the same laws as light waves, it should be possible to throw a beam in one direction by means of a parabolic reflector, but the practical difficulties in the way seem to be insuperable. It occurred to Dr. Braun, however, that he could construct a system of sending wires which could be made to intensify the wave in one direction and interfere with it in other directions. If two sending wires are tuned to exactly the same pitch and are operated by the same exciting apparatus, but are so arranged that one of them will be set in vibration a small fraction of a second later than the other, it should be possible to obtain interference. The difficulties encountered in doing this are those of tuning two oscillators to the same pitch, and of producing the desired difference in phase. New methods had to be devised for measuring these exceedingly small time differences. This has been done, but the method is not described. Extended laboratory experiments resulted in the development of means of tuning the wires and for producing the difference in phase sought without throwing the two wires out of tune.

The laboratory results agreeing satisfactorily with the theory, it remained to test the system on a practical scale. Fortunately, a suitable place for carrying out this work on a larger scale was available in the large drill ground at Strasburg, known as the Polygon, which was courteously tendered to the experimenters by the military authorities. The investigations were carried out on a small scale as compared with wireless telegraph transmission systems, since it was desirable to obtain quantitative, and not merely qualitative, results. It was intended to measure the difference in intensity of the waves sent out in different directions, and for this purpose a relatively short transmission was advantageous.

The sending station consisted of three wooden masts arranged at the corners of an equilateral triangle. Upon each of these masts was stretched a wire or antenna, from the lower point of which a connecting wire was carried to a wooden building placed at

the centre of the triangle, in which are mounted the various sending devices. By means of the apparatus contained in the building it was possible to set the wires on, say, posts 1 and 2 into synchronous vibration, and to set up a vibration of the wire on the third post of the same pitch, but which lagged or led in phase the vibrations of the other two. Assuming the vibration of wire 3 to be slightly lagging, interference between it and that of wires 1 and 2 would take place in the direction from 3 over the house at right angles to the plane containing posts 1 and 2. This amounts to throwing an electrical shadow in that direction. If, on the other hand, the vibrations of wire 3 were made to lead those of 1 and 2 by a proper amount, an amplified wave would be sent out in the same direction, and a shadow thrown backward from wire 3, and at the same time, interference on the sides would take place. In carrying out this work it was necessary to obtain great accuracy in timing the vibrations of the three wires. The time difference was about one-ten-millionth part of a second. Dr. Braun concludes from his work that it is possible to adjust the time difference to within a two-hundred-millionth part of a second. This amounts to an accuracy of one second in six years.

This system of three masts is only a particularly simple arrangement, for more sending wires might be used with an augmented effect; but for the work in hand the simplicity of the system presented some important advantages. It should be noted that transmission is not limited to one direction only with three masts, for it can be sent in the reverse direction by reversing the phase relations. By alternating the function of wire 3 with that of wires 1 and 2 it is possible to transmit messages at will in six directions. The simple addition of a commutating switch in the sending station enables this change in direction to be made easily and at will. It was found that the receiving apparatus at a particular position responded without fail when this commutating switch was in one position, and yet showed no signs when the position of the switch was changed. The distance of the sending station was in these researches 1.3 kilometres.

The results of the experiments were completely in accord with the laboratory investigation and with theory. In other words, it is possible by means of this arrangement to direct a wireless message through a fairly narrow angle. Dispersion takes place and is not small, but there is a decided electrical shadow in the reverse direction, and there is, in fact, a wide angle in which no effect can be measured. If the receiving station had been equipped for transmitting messages also, it would have had three or more antennæ, and there is no doubt that these wires could be used in an analogous way for increasing the effect at that point. The use of more than three wires would enable the transmission to be sent out through a still smaller angle, with a less degree of dispersion; but it would complicate the system somewhat.—*Electrical Review, N. Y.*

The Art of Studying.

By W. H. JONES.

(*Through pressure on our space, due to the Olympia Exhibition matter, we have reluctantly held over the Telegraphy Correspondence Class this month. Student readers, however, will profit by perusing the following article contributed to the* Telegraph Age.)

About this time in the summer season, or perhaps a little earlier, each year there seems to be a greater number of operators desiring to take up the study of electricity in its application to telegraphy than at any other period. The impetus is probably due to the fact that the opening of summer offices at seashore resorts, vacations, &c., frequently drains the main offices of a considerable amount of talent, and the loss must be replenished from such remaining operators as possess a reasonably fair degree of electrical knowledge to begin with. To this number of knowledge seekers must be added the yearly crop of juvenile operators, many of whom are ambitious to learn the secrets of the profession.

The remarkable fact in connection with this matter is that although these opportunities for advancement occur nearly every spring, and often at unexpected periods during the rest of the year, it has been found, when seeking new material, that as a rule, most of those who were naturally in line for promotion had been caught napping, and the plum was passed on to another who had been quietly acquiring a better electrical education.

The first lesson to learn, then, is: Begin early and keep at it, and remember that

knowledge must always precede both opportunity and position. Furthermore, the man who is known to have prepared himself for advancement will be the first one sought by the manager when help is needed. The next requirement lies in early convincing oneself that no rapid progress can be made or permanent knowledge acquired unless the student begins at the very bottom and thoroughly masters each problem in rotation before passing on to the next. The moment this rule is broken the thread of knowledge, so easily followed in continuity, becomes dim and hard to trace in a sectional or disconnected state. This is really the key to the situation and truthfully explains why one person possessing but ordinary intelligence, coupled with persistence, sometimes outstrips his more brilliant, but impatient, brother in a race for knowledge.

The mistake is too generally made of beginning one's studies too far along the line. Thus, a newly appointed assistant in the quadruplex department, for instance, is very apt to open his book at the chapter describing multiplex apparatus, and begin his studies at that point. Or, a wire chief may first look up the formulæ for measuring and testing conductors without bothering his head about the "whys." It is almost needless to state that those who erroneously follow this method of study rarely become expert in their calling. If one does succeed it will be found that he has acquired his proficiency, little by little, through a long see-saw course of training which in the end occupied double the time otherwise actually necessary to have gained the same amount of information.

Another requisite of rapid progress in one's studies is the possession of an observing eye. If the habit of noting the construction and prominent features of each class of apparatus employed in telegraphy is formed, and the reasons therefor are sought, the student will not only be sure to cover the entire field, but he will need no other guide as to the order of procedure. If any set of telegraph apparatus be examined closely the following principal characteristic features, as well as many others, will always be present: The uniformity in construction and material employed for the respective parts of the outfit are not due to any particular design or fancy of the maker, but to scientific principles. Patterns and decorations may differ widely, but each maker of telegraph apparatus is guided in construction and the selection of material by the master laws governing the actions of an electric current

Now, an indifferent inspection of a set of telegraph instruments will merely show that the material used is brass, copper, iron, silk or cotton, steel, wood, and platinum, and may not impress the observer with any suggestion that the arrangement is anything but one of choice or ornament. A close examination, however, of a number of different classes of instruments, disclosing the fact that the same kind of material and combinations thereof are invariably used in the construction of the individual parts performing like services, suggests that there is a special reason therefor, and the suggestion is true. The student will notice, for instance, that the crossbar armature, attached to the lever of each relay, sounder, pole-changer, transmitter, &c., is composed of iron, while the lever itself is brass or aluminium. There is no exception to this rule. He will also note that with the exception of these crossbars and the magnet cores, iron is studiously tabooed in the construction of all other parts of every apparatus containing a magnet. At least, no iron will be found in very close proximity to any magnet.

In studying the subject of electricity, then, it follows that after first devoting ample time in acquiring all the knowledge one can concerning the different types of batteries and other sources of electricity employed in furnishing current to the magnets, he should next make a special study of the electromagnets. He will act wisely if he procure one or more standard works devoted to that subject alone, as the entire system of telegraphy depends upon the methodical cooperation of the electric current and the magnets. By the time he has mastered these two most important subjects he will have learned, among other facts, that although all batteries generate the same kind of electricity, different types do not furnish it in equal quantities or steadiness. Hence certain kinds are used for one purpose and others for another. It is, therefore, well to know which type is best suited for a given purpose.

THE OLYMPIA ELECTRICAL EXHIBITION.

The large amount of space devoted to this Exhibition compels us to somewhat curtail our ordinary matter this month.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

The N-Ray Mystery.

By J. GARCIN.

(Concluded from p. 524, Vol. III.)

BLONDLOT'S sulphide screens are an extremely handy and appropriate means of detecting the presence of N-rays, and the ingenuity of searchers has been applied to the problem of increasing their sensitiveness without undue complications. One way of realising this desideratum is to use two screens of triangular shape completely covered with sulphide, the points facing each other. When the glow of the sulphide increases an optical effect is produced, and the points of the screens appear to be drawn closer together. To observe a fairly large emission of N-rays, a large screen may be utilised covered with calcium sulphide diluted with collodium, on which any sharp-edged object is placed, *e.g.*, a key, locket, or ring. The contours of this object are seen to stand out boldly on the faintly luminous backgrouud when N-rays are present, and this sharpness diminishes to a considerable extent when the source is removed. To localise a pencil of N-rays cardboard screens may be used in which small slits are cut and tightly packed with the sulphide. The variations of glow are very appreciable in this case. The foregoing are only a few of the innumerable methods for detecting the presence of the rays, and the reader will no doubt be able to devise new ones better suited to his modes of perception. Yet another re-agent may be cited—glow-worms, whose phosphorescence exhibits a marked increase under the action of N-rays.

The reader has now gathered sufficient knowledge as to the sources of N-rays and the re-agents which reveal their presence. The next question is: How are we to interpret the phenomena just discovered? The phenomena show that mysterious radiations exist which appear to proceed from certain sources and have a marked effect on certain re-agents. What are these radiations? The art of the physicist consists chiefly in evolving laws and theories from observed data, and students who wish to attain to scientific methods should study Blondlot's first communication to the Académie and note the way in which the eminent scientist interprets the facts discovered during his investigations. He observes an increase in glow of a small spark placed in the path of unknown emanations from a focus tube. This increase in glow varies according to the orientation of the spark with respect to these emanations, which shows that the latter have not the same properties in all azimuths, or, in other words, they are polarised.

This leads him to conjecture that the radiations are also susceptible of reflection and refraction and absorption, and that they therefore are a new species of light. Subsequent experiments enable him to confirm these conjectures. He finds that a prism interposed in the path of the new rays deviates them so that they no longer act on the spark, and that a quartz lens concentrates the rays just like ordinary light. He further finds that he can reflect the rays from a plane of glass. He next proceeds to a determination of their wave lengths, using the ordinary grating employed for this purpose in laboratories, and finds that this is a very small quantity smaller than the shortest ultra-violet rays known. The phenomenon known as total reflection, a good practical example of which was shown in the luminous fountains at the Paris Exhibition of 1889, can be reproduced with N-rays, for they can be conducted along a copper wire or any other wire transparent to N-rays, just as a beam of light

can be conducted along a glass tube filled with water. With regard to the absorption of N-rays an enumeration has already been given of the substances which are capable of storing them up and radiating them after the source is removed. These substances are quartz, calcium sulphide, calcareous stones, Iceland and fluor spar, barite glass and all pure metals save luminum. Wood, paper, and paraffin do not exhibit this property of absorption.

The physiological effects of N-rays have been studied by a host of physicists and medical men, and quite a number of curious phenomena have been brought to light, to which, however, the author cannot devote more than a few lines in this short article. The perceptive faculties of the eye are increased when this organ is receiving N-rays. The same effect is observed on the auditory and olfactory organs. Those who wish to enquire more deeply into this matter should read M. Charpentier's and other communications, in which experiments are related of astounding delicacy.

The discovery of radiations having properties quite distinct from those of N-rays was made by Blondlot during an experiment in which he observed a diminution in glow of a feebly luminous source. While studying the spectrum of the non-luminous radiations emitted by a Nernst lamp by means of a aluminum prism, Blondlot observed that in the feebly deviated parts of this spectrum the glow of phosphorescent calcium sulphide diminished in certain directions. This effect he ascribed to the action of new radiations which he called N_1 rays. Certain sources seem to emit N_1 rays exclusively, or at least these seem to predominate in their emission. This is the case with copper and silver wire and hard-drawn platinum wire. M. Birchat observed that ethylic ether when brought to the state of forced strain by the process discovered by M. Blondlot Berthelot, emits N_1 rays; when this state of strain ceases, whether spontaneously or under the action of a slight blow, the emission of N-rays immediately disappears. N_1 rays can be stored up like N-rays. For instance, one need only bring a bit of stretched copper wire in proximity to a lump of quartz to make the quartz emit N_1 rays for some time after. The action of N_1 rays in some cases appears to be exactly converse to that of N-rays. For instance, the action of N-rays on a dimly lighted surface is to render it more luminous; if, on the other hand, the surface is viewed very obliquely, nearly tangentially, the action of N-rays is to render it less luminous. This explains the fact, observed in all N-ray experiments, that only the observer placed in front of the sensitive screen perceives the effect of these rays. It also shows how illusory it would be to try to make an audience witness these experiments. Now N_1 rays have an inverse action in this case to that of N-rays—they diminish the light emitted normally and increase the light emitted tangentially. This is also true with regard to the physiological effects of N-rays. The visual, auditory, and olfactory organs experience a diminution in their perceptive faculties when brought near to a source of N_1 rays.

The writer hopes that he has been able to give his readers an accurate idea of what is meant by N-rays, and that his descriptions may induce some to take the matter up and explore it for themselves. A few parting hints may be given here as to the manner in which these radiations should be observed. It is indispensable in all these experiments to avoid all strain on the eye, all effort, whether visual or for eye accomodation, and in no way to try to fix the eye upon the luminous source whose variations in glow one wishes to ascertain. On the contrary, one must, so to say, see the source without looking at it, and even direct one's glance vaguely in a neighbouring direction. The observer must play an absolutely passive part, under penalty of seeing nothing. Silence should be observed as much as possible. Any smoke, and especially tobacco smoke, must be carefully avoided, as being liable to perturb or even entirely to mask the effects of the N-rays. When viewing the screen or luminous object, no attempt at eye accomodation should be made. In fact, the observer should accustom himself to look at the screen just as a painter, and in particular an impressionist painter, would look at a landscape. To attain this requires some practice, and is not an easy task. Some people, in fact, never succeed.

Olympia Exhibition Souvenir.

The Electrical Exhibits at the Olympia Exhibition will be found fully described and illustrated at the end of the usual classified matter.

Labour Saving in the Laboratory.

In the broad fields of manufacture one sees mechanical devices of every conceivable form and kind employed for the obvious purpose of saving time and labour. Large industrial establishments will be teeming with labour saving machines, but in the laboratory of the same concern little or no departure from traditional methods has been made. Strict adherence to these ancient forms of labour occasions the waste of much valuable time on the part of the chemist, whose talents might be better employed on more important work. This loss of time is a matter of greater purport than formerly, as the stress of competition and the demands of a progressive management necessitate that deeper research work be undertaken in the laboratory. Obviously, then, the chemist must abandon his old-time methods of assaying for something speedier but equally efficient. Before the American Institute of Mining Engineers recently, Dr. Ed. Keller gave some instructive data on the substitution by machinery of manual labour in the laboratory, describing the equipment of the Baltimore Laboratory of the Anaconda Copper Mining Company. A direct result of the Keller labour-saving appliances is a marked economy in the laboratory work generally, but especially in the matter of glass breakages. The most marked difference, however, is noticed in the greatly increased output of the laboratory, that is, so much more work can be done by a man in a day. At the Baltimore Laboratory assaying is chiefly done and scores of silver determinations and hundreds of scorifications and cupellations for gold are often made. What is known as the combination method is employed for this, the process comprising the dissolving of both the copper and the contained silver in nitric acid, leaving the gold as a metallic residue. The silver is precipitated as chloride, and with the gold is separated by filtration from the copper solution. The incineration of the filter, scorification with metallic lead, and cupellation with a subsequent parting of the two precious metals, concludes the assay. By using metallic trays for holding nine Griffin beakers, Keller simplifies the handling process considerably, as the nitrous fumes can be expelled by boiling the solutions without handling the beakers separately. Stirring of the mixture is absolutely necessary to the further stages of the process as the reaction must be uniform throughout, and after adequate settling no silver chloride must run through the paper. Dr. Keller introduced a stirring machine by which ten beaker solutions could be kept in motion at one time. A revolving disc is fitted over each beaker into a horizontal wood strip running over all the beakers and supported at the ends by uprights hinged to fall back and permit of the removal of the glasses. By gearing and belt drive, the stirring discs are revolved, and there is neither splashing nor fear of breakage of the beakers. Any size of vessel can be used as the stirring rod is adjustable over several diameters. The stirring rods and discs can be removed bodily and transferred to another set of beakers after washing.

In the same laboratory is used Dr. Keller's machine filter, by which twenty filtrations can be effected in the time taken for one. A stand is provided for the beakers and a rack for the filters, the solutions to be filtered being in beakers which are clipped into a tilting frame operated by a single handwheel. Glass rods guide the stream of liquid to a definite point in the filter to ensure steady pouring. The entire load is balanced by a counterpoise, and filtering can be done quite leisurely with one hand.

Tables were given in Dr. Keller's paper comparing the times occupied by hand and machine filtration. These we reproduce:

TABLE I.—COMPARISON OF RESULTS OF MACHINE FILTRATION *v.* HAND FILTRATION.

MACHINE FILTRATION.		Time, Minutes.
10.21 a.m.	Started	—
10.22 a.m.	Placed Rods	1
10.30 a.m.	Finished decanting	8
10.41 a.m.	Washed beakers and rods	11
10.45 a.m.	Washed filters	4
10.55 a.m.	Rubbed out beakers	10
10.59 a.m.	Folded filters and placed in scorifiers	4
Total		38

HAND FILTRATION.		Time, Minutes.
11.13 a.m.	Started	—
11.14 a.m.	Placed rods	1
11.38 a.m.	Finished decanting	24
11.58 a.m.	Washed beakers and rods	20
12.04 p.m.	Washed filters	6
12.13 p.m.	Rubbed out beakers	9
12.13 p.m.	Folded filters and placed in scorifiers	4
Total		64

Difference in favour of machine, 26 minutes.

Another marked economy has been effected in the Baltimore Laboratory by the elimination of the familiar wash bottle. The distilled water is placed in carboys fixed some 5ft. above floor level, and syphoned into a system of glass tubing run round the laboratory benches. At frequent intervals T connections with rubber pipes and glass nozzles are taken off, so that the water can be used and distributed everywhere with ease. The supply is maintained by forcing water under compressed air into the upper carboy. A beaker cleaning machine is also employed by Dr. Keller, the beakers in this case being rotated round a fixed "rubber" comprising a cork covered with filter paper which can be readily renewed.

Glass Fusion by Electricity.

An elaborate study has been made by M. Bronn of the various electrical furnaces designed for the production of glass. His deductions were recently published in the *Bulletin de la Société d'Encouragement* of Paris, and are abstracted in the following lines:

Most of these furnaces are of the arc type, and all have certain disadvantages. The radiation loss is great, and where carbon electrodes are employed, carbon dust is thrown off by the electrodes and mingles with the glass. This dust increases with the length of the arc, and attempts have been made to overcome this disadvantage by adding oxidising materials to the raw material, but with indifferent results. Tests have been made with metallic electrodes, but brass electrodes melted, and iron electrodes became magnetised and were drawn into contact. In some systems the arc is produced above the glass, and is deflected against the material by an electro-magnet. This has certain advantages, but the pointed form of the arc raises the glass to a high temperature locally, and frequently burns through the side of the containing vessel. Experiments made with furnaces of this arc show that from four to six kilowatt-hours are required to produce a kilogramme of molten glass. The glass obtained contained considerably more silicon than the ordinary mixtures, so that this electric furnace should be useful if glasses of this type are desired; but for ordinary purposes it is too costly to operate.

Another furnace having advantages over the arc type is that in which the heating material is powdered carbon or kryptol. In these furnaces the material to be fused is placed in a containing vessel, which is then surrounded by the resistance material. This ensures an effective heat insulation, and reduces very greatly the radiation losses. When putting in the resistance material it must not be tightly packed, and the grains must be of uniform size and evenly distributed around the crucible. The arrangement of the furnace may be such as to produce a higher temperature at one part than at another. One difficulty with this class of furnace is the high current density employed, but a suitable regulating rheostat has been devised consisting of an insulated cylinder filled with the powdered material. A block of carbon at the bottom forms one electrode, and the second electrode is a carbon rod which is forced down into the loose material. The conducting mass may be distributed around the crucible in various ways. In some methods triangular strips of carbon are placed in contact with the crucible to concentrate the current at certain points. By this arrangement the glass may be fused at low temperatures compared with the temperature of the arc. The furnaces may also be regulated to give any temperature up to 1,600 to 1,700° C., with a precision of 10 to 15 per cent. The voltage used in the experiments was about 100.

Every aspect of the design and manufacture of electrical apparatus will be dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

The Design of Induction Motors.

By H. M. HOBART.

(Concluded from p. 176.)

WE have next to consider the motor as to its efficiency and heating. The number of turns must be distributed uniformly over the circumference. The cross section of each turn must be chosen with due reference to the total I^2R loss as affecting not only the heating but the efficiency. The dimensions of the iron must be so chosen as to give a suitable density in the teeth and in the core. By taking as densities the values given in the following table, a sufficient approximation for a preliminary design can be obtained.

Current density in stator winding:
: Between 200 amperes per square centimetre and 350 amperes per square centimetre. The limit in induction motor design relates to efficiency more than to heating. Thus, were it customary to permit lower efficiency, higher current densities could be used.

Current density in rotor winding:
: Density in wound rotors to be chosen approximately the same as in the stator. For squirrel cage motors with high starting torque the density must be chosen to correspond with the starting torque required.

Tooth density in stator:
: Varies between 13,000 and 20,000, the higher value to be taken for low frequencies.

Tooth density in rotor:
: Varies between 16,000 and 22,000, the higher value to be taken if the guaranteed no load current permits.

Core density in stator:
: Varies between 4,000 for very high frequency designs to 8,000 in designs for low frequencies.

Core density in rotor:
: Is chosen simply with a view to avoiding such degrees of saturation as to entail any considerable magneto-motive force to overcome the reluctance of this part of the magnetic circuit.

The dimensions of the motor having been determined, the following tabular form will be useful in the estimation of the losses:

I.

R.M.S. current in stator winding...... =
Warm resistance of stator winding in ohms per phase .... =
I^2R loss of stator per phase .... =
Number of phases .... =
Total I^2R loss of stator .... =

II.

(A) *Wound Rotor.*

Equivalent R.M.S. current in rotor winding for ratio of transformation of 1 : 1 .... =
Number of conductors in stator .. ... =
Number of conductors in rotor ... .. =
Ratio of transformation .... =
Actual R.M.S. current in rotor winding =
Warm resistance of rotor winding in ohms per phase .... =
I^2R loss in rotor winding per phase ... =
Number of phases in rotor .... =
Total I^2R loss in rotor................. =

(B) *Squirrel Cage Rotor.*

Equivalent R.M.S. current in rotor bar for ratio of transformation of 1 : 1 =
Number of conductors in stator ...... =
Number of bars in rotor .... =
Ratio of transformation .... =
Actual R.M.S. current in rotor bar ... =

Resistance of all bars in series ...... =
I^2R loss in rotor bars .... =
Number of bars per pole (Z) .... =
$\frac{Z}{\pi}$ .... =
R.M.S. current in end rings ($=\frac{Z}{\pi}\times$ current in bar) .... =
Resistance of two end rings in series =
I^2R loss in end rings .... =
Total I^2R loss in rotor .... =

III.

Weight of stator (before punching out slots, in kilogrammes) (A) .... =
Density in stator iron in kilolines per square centimetre .... =
Periodicity .... =
$\frac{\text{Periodicity} \times \text{density in kilolines per square centimetre}}{100}$ = (B) =
Losses in stator ($1.2 \times A \times B$) .... =
Losses in rotor iron (estimated) ...... =
Total iron losses .... =

IV.

Bearing and windage losses .... =

Total of constant losses ... . =
Total of variable losses .... =
Total of all losses .... =
Watts output .... =
Watts input .... =
Efficiency .... =

The heating is estimated from the total I^2R and iron losses in stator and rotor in watts per square decimetre of cylindrical surface. The cylindrical surface may be taken as equal to ($\pi \times$ diameter at gap) $\times$ (gross length $+ 0.7 \times$ pole pitch). The permissible values for a temperature increase of 40° C. vary between 30 and 60, the higher value to be taken for high peripheral speed and good ventilation through ducts.

Commutating Poles for Direct Current Machines.

By Dr. ROBERT POHL.

(Concluded from p. 178.)

THE commutating poles as introduced in England by the Phœnix Dynamo Manufacturing Co., Ltd., Bradford, are of such a special form as to produce perfect commutation by inducing into the short circuited coils an E.M.F. which follows the law for perfect commutation given in equation 2, and simultaneously they almost entirely avoid the previously-described drawbacks. To begin with the latter points, it is obvious that there is no need to have the auxiliary poles covering the whole armature length, as a calculation will show that in this case the magnetic density would be very low indeed. Returning, for instance, to the example given previously of a 250kw. machine, we find that the E.M.F. induced in one armature coil, while passing under the pole, amounts to about 10 volts, whereas, we saw that the reactance voltage was not greater than 2.4 volts. Consequently, to produce this voltage, we can reduce the axial length of the auxiliary pole to about a quarter of the armature length if we assume similar magnetic densities for both pole faces. By this means we keep the increase of reactance voltage very low indeed and also reduce the increase of leakage and the deterioration of the ventilation to a negligible degree, whereby, at the same time, we effect a saving of copper for the excitation.

It is needless to say that the magnetic path for the auxiliary poles has to be calculated as carefully as the main magnetic circuit in order to keep within the favourable limits of saturation, which had to be found out by experiment.

When reducing the axial length of the commutating poles, we find at the same time a very simple, but nevertheless effective method of producing perfect commutation. We form the face of the auxiliary poles as shown in Fig. 3, and thus produce more lines towards the main pole of opposite polarity at exactly such a rate as to obtain the theoretically ideal curve of E.M.F. given in Fig. 4. This curve of E.M.F. compared with Fig. 2 shows a constant value over the entire zone of commutation, in

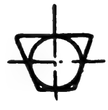
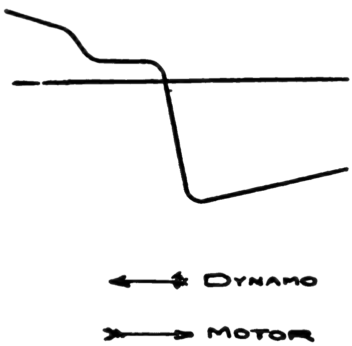


Fig. 3.



Elec Mag 1501

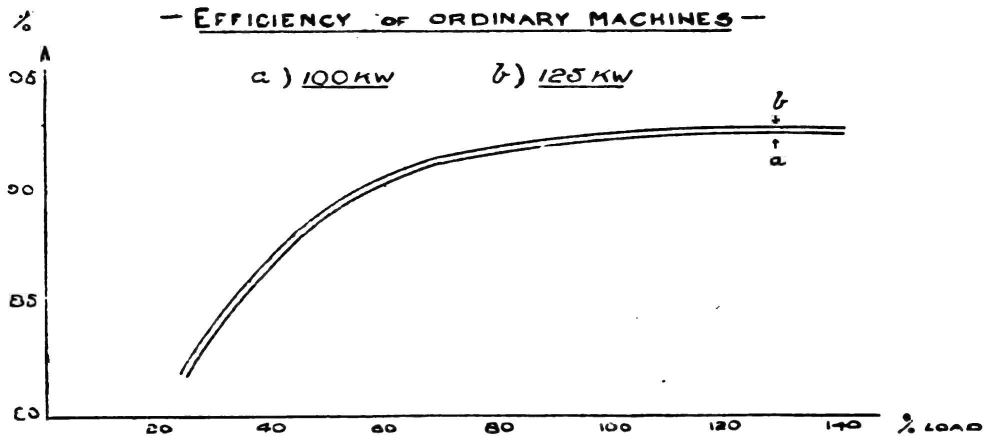
Fig

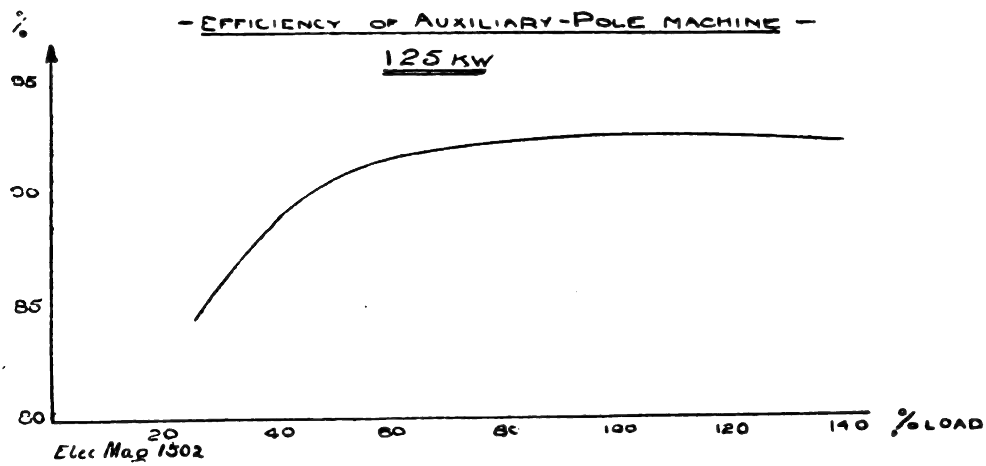
accordance with the requirements for perfect commutation deduced from equation 3. In order to fix the right form for this shoe, the distribution of the flux in the neutral zone due to the main poles has first to be found out, after which, for every point, the difference between the actual and the required field, and the corresponding width of the auxiliary pole, will easily be found.

An E.M.F. curve as given in Fig. 4 is for several reasons very valuable; first of all, as the conditions of commutation are alike over a large part of the neutral zone which is influenced by the auxiliary poles, there is obviously the possibility of shifting the brushes inside the limits of this zone freely, and there will be no difference in the perfect form of commutation. If the pole arc of the commutating pole is sufficiently large compared with the actual commutating zone, the brushes can be moved forward and backward from their middle position; thus in the case of a dynamo the voltage or the amount of compounding can be regulated by the brush position, and even full compounding can be obtained by moving the brushes backwards without any series winding on the main poles. Further, in the case of motors, the speed may be regulated; and either a positive or negative compounding effect can be produced: that means, either an increased starting torque or constant speed between no load and full load are obtainable. If such effects are not demanded, the marked insensitiveness of the brush position in itself is a very valuable feature in practice; or it is possible to use exceptionally wide brushes, and to reduce in this way the commutator dimensions. As the factor $\frac{L + 2M}{T}$ decreases with increasing width of brushes, we reduce thereby, at the same time, the reactance voltage. We have seen already that with the described form of shoe there are practically no short circuit currents. Consequently we do away with all additional commutator losses, which in an ordinary machine form a great part of the total commutator losses. So there is no fear of the commutator getting too hot.

A series of experiments carried out by the Phœnix Dynamo Manufacturing Co, Ltd., showed all the described effects which were theoretically expected, especially the effectiveness of the shape on the form of commutation, which could be studied not only by its results as to overload capacity and possibility of shifting the brushes, but more detailed still by taking the commutation diagrams in the method described by Arnold. In this way it was found that the commutation was, indeed, practically ideal, and remained unaltered while the brushes were shifted over a distance corresponding to more than half of the neutral zone, and that, further, with very wide brushes covering nearly this whole distance, there was only a very slight deviation from the straight form of commutation. The overload capacity was in many cases about 200 per cent. Further, an increase of the speed with proportionately increased output for a machine running as a dynamo had scarcely any effect on the commutation, so that even a 500 volt dynamo running with twice the normal speed was able to produce 1,000 volts and the double output. For motors any speed regulation required in practice by shunt resistance only could be obtained without fear of sparking.

It may be allowed to add a few words as to the importance of the described improvement. All machines hitherto built with these auxiliary poles prove the fact that the sparking limit has been so enormously extended that it is not at all necessary to take it into account when fixing the output of a given machine. In all cases the output may be raised to the temperature limit, which for medium and larger sizes of ordinary machines lies, as a rule, far above the sparking limit. Thus, for a given output the active material and the price can be more or less considerably reduced. Nevertheless, there remains a valuable improvement in quality, as the commutator requires a good deal less careful treatment. As a matter of fact, the commutator has practically lost its undesirable qualities which were so often the cause of trouble in direct current machines, and the cause of their inferiority compared with three phase machines. There is another advantage regarding the efficiency; Fig. 5 may represent the efficiency curves of ordinary machines, (*a*) for a 100kw., (*b*) for a 125kw. machine. We equip now the 100kw. machine with auxiliary poles, whereby there is no increase of losses; if we reduce the air-gaps simultaneously, and increase the nominal output say, 25 per cent. to 125kw., we have the same efficiency curve as before, but the scale of the load has to be altered. In this way we obtain the curve in Fig. 6. The efficiency





Figs. 5 and 6.

at full load is about the same as that of the ordinary 125kw. machine, whereas there is a marked difference in favour of the auxiliary pole machine for ¾, ½, and ¼ load. The efficiency is,

	For 25 per cent. overload.	Full load.	¾ load.	½ load.	¼ load.
Ordinary mach. :—	92.8	92.6	91.9	89.3	82.3
Aux. pole mach. :—	92.6	92.7	92.3	90.75	84.2

Whilst the efficiency of ordinary machines as a rule is at its highest at about 25 per cent. overload, for machines of this kind it reaches its maximum at full load or even at ¾ load. This alteration in the form of the curve is very desirable, because many machines are only for short periods fully loaded, and the efficiency at ¾ and ½ load is generally of higher importance than at full load.

Finally it may be pointed out that the described commutating poles are specially adapted to the solution of a problem which is becoming more and more important, namely, the construction of high speed continuous current dynamos for direct coupling to steam turbines. The experiment has already proved that even the very great difficulties regarding commutation which occur with machines of this kind can be completely overcome, and that absolutely sparkless running with fixed position of brushes can be obtained. A specially difficult high-speed dynamo for 70 to 80kw. at 4,000 revolutions per minute is at this moment under construction in the Thornbury works of the above named company.

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

Continuous Current Networks, Metallic and Non-Metallic Sheathed Cables.

By L. R. LEE, Manchester.

(Concluded from p. 180.)

THE fifth method results in something better than the fourth as it breaks up the lead into comparatively short lengths, and one length being broken down does not affect the others, and as it is agreed that good cable will not give trouble, this method should be entirely free from trouble of any sort.

The method described in (6) can be likened to the first, but the lead is put in parallel path with earth, and as all tees are bonded the second earthing, *i.e.*, at the far end, only becomes another earth plate, and it is difficult to see that any useful purpose is accomplished; in fact, where is the far end of a cable in a big network? Now the question is, why should engineers give themselves all this extra worry by using metallic sheathed cables, when cables every bit as good are to be got without metallic sheaths? The only reason for using a lead sheath is to keep out water, and every well-made V. B. sheath will do this quite as well, providing the troughing in which the cables are laid is what it should be, *viz.*, rigid. The ideal troughing is the one without a joint from end to end. Many faults have been caused on V.B. sheathed cables, by the vibration or slight movements obtained at the junctions of the various lengths, and for this reason pot troughs, though chemically indestructible, are not good; there are far too many joints and consequent cracks in the filling bitumen. Iron troughs are better to make for greater rigidity, but they are undoubtedly expensive in first cost and their life in the ground is doubtful. What should be an ideal system is now being tried in Manchester. A pitch-pine troughing (prepared by the Haskinising process) is being used, together with iron junction cradles and bends (vertical and horizontal). The iron cradles are made to pull the ends of the troughings into line and to rigidly keep them there (see Fig. 3) by means of the draw allowed. The Haskinising process is one by which the wood is treated under a temperature high enough to liquefy all the gums, &c., in the wood and to impregnate the wood with them, as well as to destroy all germ life in the wood, which life

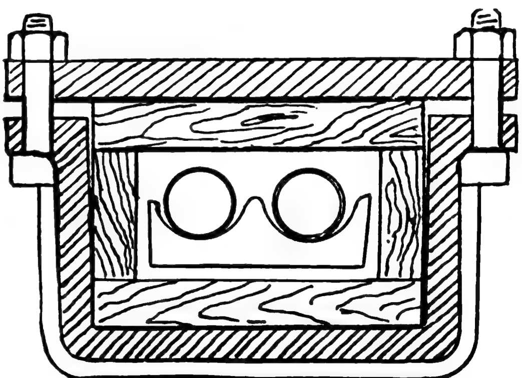


FIG. 3.

would bring about fermentation or rot. It is claimed that the timber thus treated will not rot; this, of course, only time can show. This method is also as quick as if iron were used for laying, as there is, or should be, no joinery work.

With reference to the recent breakdown at Bradford, it has been said in print that the lead on the cables was not bonded, as if this non-bonding was the cause of the trouble; after having looked at the question from all points of view, should we not rather say how fortunate for the rest of the cables (*i.e.*, those that did not break down) that they were not all bonded? If it were possible to trace the sequence of these faults, it is almost certain that we should find the second and subsequent faults were of opposite polarity, or rather started with opposite polarity to the first. On all large old networks, where the one pole is earthed, even momentarily, a breakdown on the opposite pole follows.

Again it was stated, with a view to keeping the insulation value of a network up to the mark, that it is easy to test the insulation value of a network while it is alive; granting that it is easy, how is one to separate the insulation figure appertaining to the consumers' installations from the figure representing the network? And again, having found that during the ten minutes that one has been testing, his network has fallen from 5 ohms to 4.5 ohms, what is one to do next? On a large network of such dimensions as we have been speaking of, the insulation value is altering every minute or so, and although you have a ten-ampere earth on, in five minutes more Mr. X has gone to dinner and taken his earth with him—at least, so some of us find things. About the best thing to do, after having subdivided the network as far as possible, and having emergency arrangements at one's fingers' ends, is to watch the out-of-balance earth recorder intelligently, and to be prepared; meanwhile to do all work as well as it is possible to be done, not stinting money. What costs most now will be cheaper in the long run.

A very useful paper was recently read before the Manchester Section of the I.E.E. entitled "Some Points on the Selection of Electric Cables," by Messrs. L. B. Atkinson and C. J. Beaver, which paper should go far to enlighten the engineer on some hitherto obscure points in connection with the manufacture of cables; but on page 22 we find this statement: "It is obvious that bonding and earthing frequently and sufficiently is the remedy for electrolytic faults." Now having looked at the question from other points of view, is it so obvious? or, as I heard a day or two ago, "Should we not see that the copper conductor is the only part of our cables that can possibly carry current?"

Arcing Troubles on Switchboards.

THE flashing over of charged metal surfaces having great potential differences on high pressure switchgears is not commonly met with, but it is well to be familiar with some of the conditions of a circuit which give rise to such occurrences. In European practice barriers are generously used between conductors differing in polarity and phase; consequently breakdowns due to the jumping of an arc from metal to metal are rarely encountered. In some instances, however, great surface distances have been bridged through excessive potential rises, and troubles of this kind may at any time be experienced. In a paper read before the Ohio Electric Light Association, Mr. H. L. Wallau pointed out some of the circumstances generally responsible for fires on boards, due to serious arcing. We abstract the following from his paper as of value to engineers in control of high pressure plant:

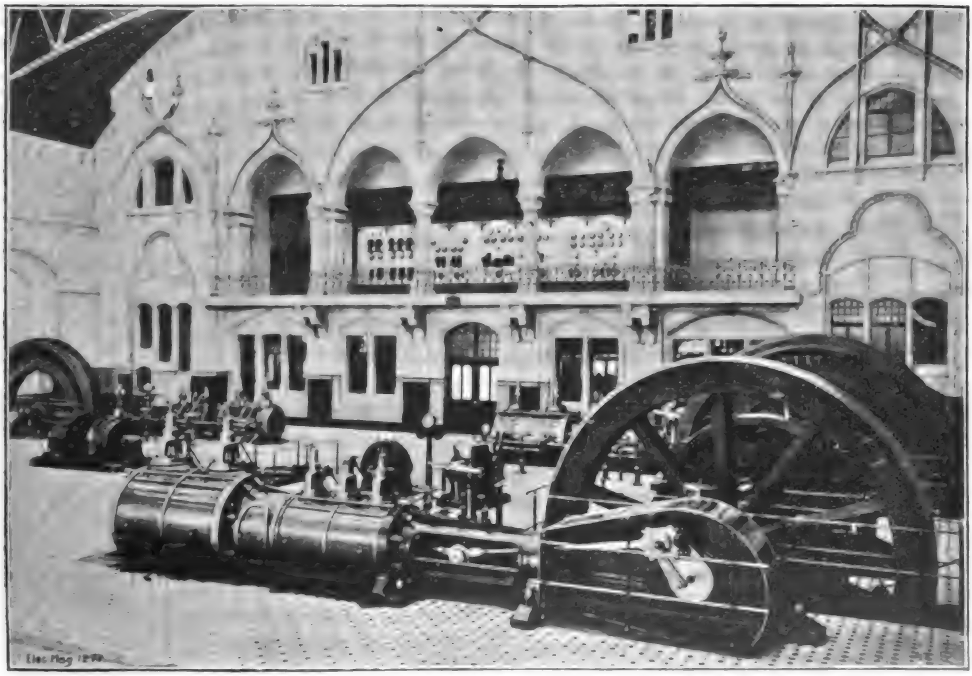
"When a current flows through a circuit containing inductance energy is stored in the line by virtue of the magnetic field produced by that current. If the electro-motive force producing the current is suddenly removed, the stored energy must be returned to the supply circuit before the current can stop. This action generates momentarily a potential higher than normal. This potential is in such a direction as to continue the current flow. When a sudden rush of current encounters in its path a choke coil it experiences great opposition for an instant. This opposition, if the current be sufficiently great and practically instantaneous, will cause a very high voltage back of the choke coil, which tends to short circuit it and side-flash. After the first instant the coil will allow current to flow through it at an accelerating rate, thus relieving the pressure. When a condenser discharges suddenly into an inductive circuit of low resistance practically all of

the charge is stored as magnetic energy. This, in turn, on cessation of the condenser current, restores to the condenser almost the entire original charge, and so an oscillatory discharge takes place until all of the energy has been dissipated in overcoming the low resistance of the circuit. The condenser, therefore, oscillates between zero and double potential, gradually assuming the potential of the circuit. Now, all conductors have electrostatic capacity, or are condensers. Lines have capacity between wires and between wires and earth. If transformers are connected to the lines, these have capacity between primary and secondary coils and between coils and core. If the secondaries are grounded, as is common practice, a large charge may be induced in the primary coils without greatly raising their potential. All lines also have inductance, and with transformers in circuit this may be quite considerable."

Mr. Wallau then quotes his experiences of arcing troubles, and refers to a high pressure three phase gear in which barriers were not used between the connecting conductors. The feeder panels included bus bars, current transformers, expulsion fuses, and switches, and the effects of a short circuit are closely detailed:

"The short circuit comes on; a sudden rush of current takes place. The current transformers offer but little impedance to the flow, the fuses none, but not so with the series coils of the recording wattmeters. These very effectually choke back the current and allow a high potential to accumulate. This potential side-flashes and short circuits the series coils of the meters. A heavy arc is established and holds, vaporising the metallic parts at these points, and coating the marble panel with metallic copper deposits. Meanwhile the fuses blow. The magnetic energy now stored in the line is restored to the generating circuit with a sudden rise of potential. The conducting vapours due to the arcs below enable this potential readily to jump, and this is followed by short circuits between phases at the back of the fuse panel.

"The vapours generated continue to be



CHARLOTTENBURG ELECTRICITY WORKS.

The horizontal slow speed sets are operating 1,100kw. three phase alternators and 880kw. continuous current generators.

Control Gallery, Brussels Central Station.

deposited on adjoining panels until all the panels of one group have been more or less fouled by copper deposits, and several panels are blazing away. All this happens before the operator can open the tie switch, making that section of bus dead. Before this section can be put in operation again, all of these fuse panels must be removed, the panels thoroughly cleaned of all copper deposit, meter leads inspected, &c. It may seem strange to some that the series coils of the meters could possibly have such a large choking effect. It is well to recall in this connection that this effect is proportional to the square of the number of turns and to the rate of change of the current value in the circuit. As a further proof of their choking effect, I may add that if the short circuit current passed through the meters, its volume would cause a very appreciable demagnetisation of the drag magnets, and the meters would run fast. The fact that these meters seldom need recalibration after a short circuit of this character shows that only a small part of the short circuit current

Motor-operated Oil Switches, Brussels Central Station.

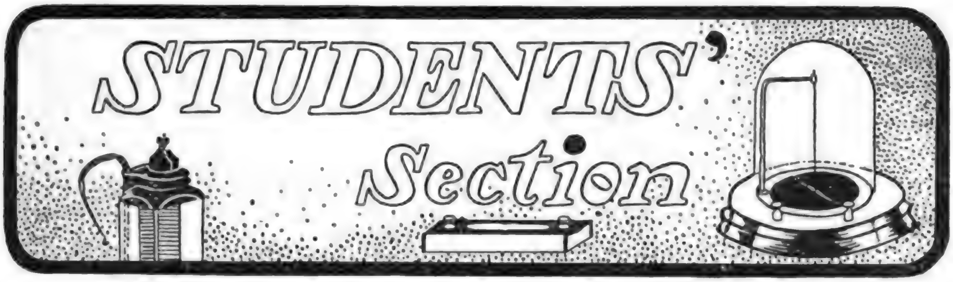
could have passed through them. Naturally, short circuits as destructive as the one described were not common occurrences, and with identical line conditions the effect at the switchboard would be very different with 1,000kw. connected to the bus and with 5,000kw. in operation. In fact, instances of trouble of this kind become more and more numerous as stations grow, partly due to a larger territory for line short circuits to

Bus Bars and Station Feeders, Brussels Electricity Works.

develop in, but principally due to the increased short circuit current available with increased generator capacity.

"These troubles were entirely remedied by the use of barriers."

The illustrations on this page give some idea of how barriers of both brick and insulating material are arranged to protect conductors on a modern switchboard. We think their reproduction quite appropriate to Mr. Wallau's remarks, as bearing out to the full his contention that barriers should be employed to shield high voltage connections.



Students should refer to the World's Electrical Literature Section for classified list of articles of special interest to them.

Problems on Distributing Networks.—VIII.

By ALFRED HAY, D Sc., M.I.E.E.

(Continued from Vol. III., p. 534.)

THE method of procedure will now be obvious. We go on introducing corrections into the variables, gradually reducing the errors of the equations until the required degree of accuracy is reached. It is best to arrange the work systematically, in tabular form, corrections of the variables being entered in one table and values of the errors in another. Continuing the calculations as already explained, we thus arrive at the following results, after the first seven corrections:

TABLE OF CORRECTIONS OF VARIABLES.

Δv_a	Δv_b	Δv_c	Δv_d	Δv_e	Δv_f
—	—	—	1.2	—	—
—	—	—	—	.5	—
—	—	—	—	—	1.1
—	—	—	—	.3	—
—	−.3	—	—	—	—
−.13	—	—	—	—	—
—	—	−.22	—	—	—

The corresponding table of errors is as follows:

E_a	E_b	E_c	E_d	E_e	E_f
34.84	92	48	−113.6	− 40.6	− 70
22.84	32	48	− 1.6	− 80.56	− 70
22.84	32	48	− 18.25	− 5.56	− 86.63
13.68	32	7.3	− 18.25	− 42.19	− .06
21.18	2	14.8	− 13.24	+ 2.81	− 10.05
.22	5.25	17.12	− 11.94	2.81	− 8.97
4.15	10.75	− .49	− 11.94	2.81	− .83

It is always advisable to check the results obtained from time to time. Thus, having made the first seven corrections, we arrive at the following values of the variables:

$v_a = 2.8 - .13 = 2.67$; $v_b = 4.8 - .3 = 4.5$; $v_c = 4.8 - .22 = 4.58$; $v_d = 3 + 1.2 = 4.2$; $v_e = 1.2 + .5 + .3 = 2.0$; $v_f = 3 + 1.1 = 4.1$,

and on substituting these in our original equations (1) to (6) (p. 533) we find values of the errors corresponding to those in the last row of the table of errors given above. Having thus verified our results, we proceed with the calculation, extending our tables of corrections and errors until the latter become negligible. The values for which the latter condition may be taken to be fulfilled are:

$v_a = 2.634$; $v_b = 4.42$; $v_c = 4.555$; v_d 4.281; $v_e = 1.998$; $v_f = 4.095$.

The determination of the current distribution in the various members of the network when loaded at the nodes only, as

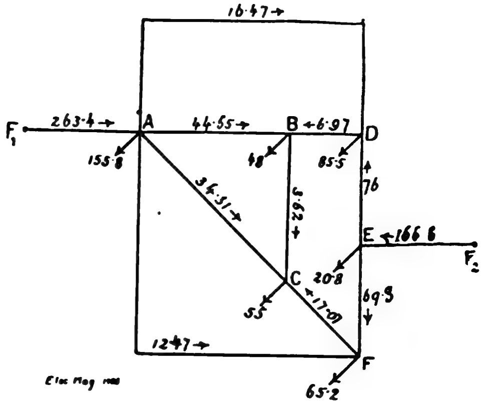


FIG. 24.

shown in Fig. 23, now becomes a very simple matter—the current in any member being equal to the drop along that member, multiplied by the conductance. The conductances are indicated in Fig. 23. We thus find:

Current along $F_1A = 100v_a = 263.4$ amperes.
Current along $AB = 25(v_b - v_a)$
$= 44.65$ amperes, &c.

The values of the currents in the various members are given in the following table:

nodes only), they also give the actual drops in the real distribution; for in the first imaginary distribution each node is a feeding point, and hence the drop to it from either of the real feeding points is zero; so that when the two distributions are superposed, the drop to any node is the same as that in the first imaginary distribution. We thus get:

$$\begin{aligned} \text{Drop to } L_1 &= v_d + \text{drop along } DL_1 \\ &= v_d + .01 \times 54 + .01 \times 19 \\ &= 4.281 + .54 + .19 = 5.01 \text{ volts.} \end{aligned}$$

Member	F_1A	AB	AC	AD	AF	BC	DB	FC	ED	EF	F_2E
Current	263.4	44.65	34.31	16.47	12.47	3.62	6.97	17.07	76	69.8	166.6

The complete current distribution is shown in Fig. 24.

The final step in the solution consists in superposing the two imaginary distributions corresponding to Figs. 22 and 24. The result of the superposition is shown in Fig. 25 (the values of the currents have been rounded off to include only the first decimal place). It will be seen that there are five points of lowest potential, indicated respectively by L_1, L_2, L_3, L_4, and L_5. The resistances and currents corresponding to the various members of the network being known, the drops to the points of lowest potential are easily calculated. The readiest method of obtaining these drops is, however, to make use of the already known values of v_a, v_b, &c. It is evident that although these correspond to the drops in the second imaginary distribution (network loaded at

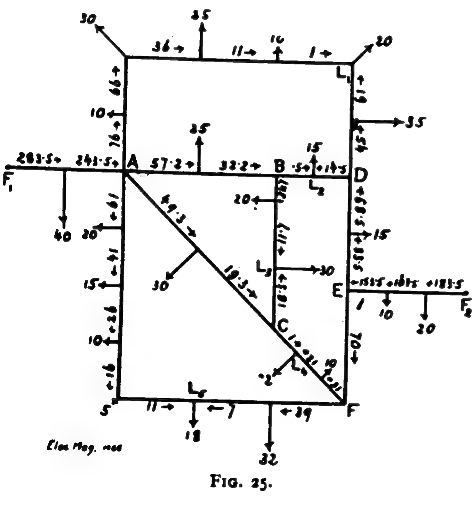


Fig. 25.

Applying the same method to the remaining points of lowest potential, we arrive at the values set forth in the following table:

Point	L_1	L_2	L_3	L_4	L_5
Drop	5.01	4.43	4.85	4.56	5.02

This shows that L_5 is the point of absolutely lowest potential. The solution of our problem is now complete.

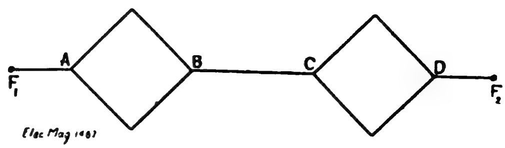


Fig. 26.

Special Methods of Attacking Network Problems.—The Coltri-Seydel method just explained of determining the current distribution in a given network is perfectly general, and possesses the great advantage of enabling one to check the work at any desired stage. In some cases, a considerable simplification may be introduced by the aid of various artifices. Whether any substantial saving as regards the time required for the complete solution is thereby secured in the most general case of a complicated network is open to question, but there can be no doubt that in various special cases the application of special methods leads to a much speedier solution than a recourse to the general method.

In the general method, the solution is obtained by the superposition of two imaginary distributions, one of which is such

that every node is a feeding point, while in the other the load currents are entirely confined to the nodes. Now—as must have been amply evident from a study of the numerical example fully worked out above—the solution of the first case presents no difficulty. It is the second imaginary distribution that is so troublesome. In dealing with special methods, we shall therefore confine our attention entirely to networks *loaded at the nodes only*.

As a first example of a special method, we may consider the case of a distributing network of the form shown in Fig. 26. The first step consists in substituting for the actual load distribution our two imaginary distributions. Now if we consider the second imaginary distribution, in which the load currents occur only at the nodes A, B, C, and D, then, following the ordinary course, we should have to write down four equations corresponding to the four nodes. This, however, is obviously quite unnecessary in the present case, for we may substitute for the two parallel paths between A and B, and also those between C and D, single equivalent conductors, thereby converting the network into a simple length of distributor connecting the two feeding points F_1 and F_2, the solution for which may at once be obtained.

How to make an Electric Buckboard.

By J. C. BROCKSMITH.

(Continued from p. 189.)

Fig. 11 is an end elevation of the field frame and armature core. The bore is $3\frac{9}{16}$in., and the core is $3\frac{1}{2}$in in diameter and has eighteen round slots $\frac{13}{32}$in. in diameter. These discs are a standard size in use by one of the leading electrical manufacturing concerns and can be purchased from stock, or they can be produced by the builder by the process of drilling the slots already described in connection with previous small motor designs.

Fig. 12 is a section of the field casting, which shows the width of the yoke and the offset of the poles. No pole shoes are used, the field coils being simply slipped over the poles and retained in position by means of hardwood wedges driven in between the core and the coil. At four points around the circular yoke holes are drilled and tapped for $\frac{3}{8} \times 2$in. hexagonal cap screws, which serve to fasten the bearing shells to the field frame. In finishing the field casting the polar space is bored out and the ends of the circular yoke faced off. The outer surface of the yoke also should be

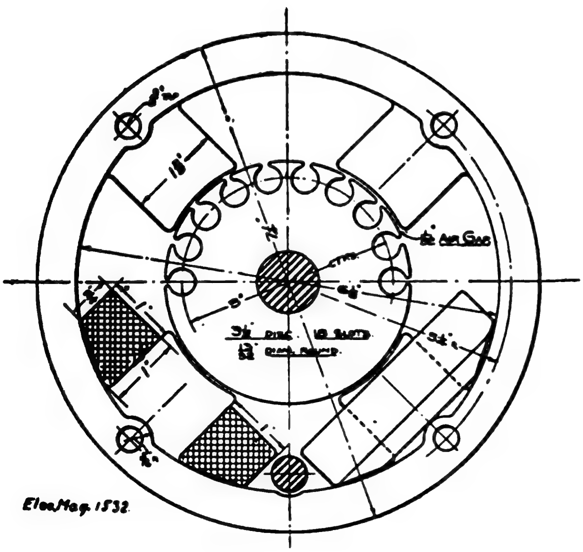


FIG. 11. END ELEVATION OF FIELD FRAME AND ARMATURE CORE.

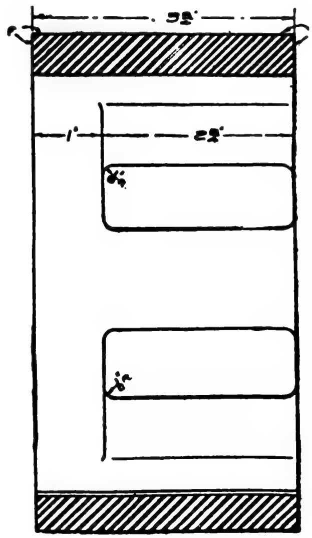


FIG. 12. SECTION THROUGH FIELD CASTING.

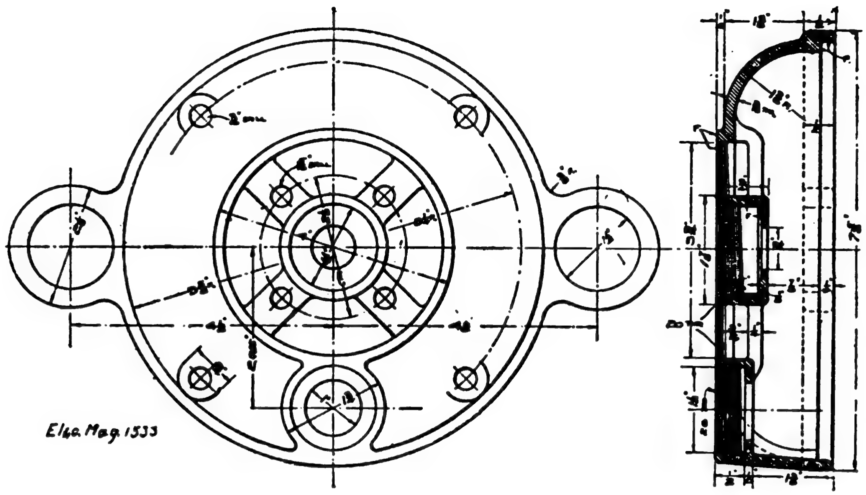


FIG. 13. DETAILS OF MOTOR COVER, PLATE, AND BEARING BOSSES.

trued for a distance of about ¼in. from each end, so as to afford a true seat for the bearing caps, which must be bored on their inner surfaces to fit the finished portions of the yoke.

Fig. 13 shows the details of the cover plate both in elevation and section. It consists of a curved shell, which covers the field coils, and in the centre of which is the case for containing the ball armature bearings. This is supported from the wall of the shell by means of four radial arms, which also serve to support the brush holders, for which purpose they are drilled with $\frac{5}{16}$in. holes.

A circular boss is located 2.725in. below the centre of the armature shaft, and is bored and threaded for the tool-steel ball cups forming the counter-shaft bearings. This centre to centre distance must be exact, for upon this depends the proper meshing of the gears. It is better to err on the side of having it a little full rather than scant. The case for containing the armature ball bearings is to be bored and threaded to suit the steel races, the bore being, of course, exactly concentric with the finished portion on the inner periphery of the shell which fits the field frame. The armature bearings are of the "grooved shaft ball bearing" type, which can be obtained ready made in standard sizes, of which this is one. They consist of three hardened and ground tool-steel races and a set of 12¼in. balls. One of these races is in the form of a spool which fits the shaft snugly, while the other two fit the case, one being threaded for the purpose of adjusting the bearing.

(*To be continued.*)

From Professor to Student.

Will you please explain the best method of calculating the capacity of a three core three phase lead-covered cable? Most books give the simpler cases but shun this, which is most important. What is the function of the thin copper strips placed round the cable just below the lead covering?

The problem of capacity in a three-core cable is a difficult and complicated one, and has only received the attention it deserves comparatively recently. It is, of course, incorrect to speak of the capacity of a three core cable; for the value of the capacity depends on the conditions under which the test is carried out. The capacity, for example, between two of the cores when the third core and sheath are both earthed is different from the capacity between the same two cores when the sheath is earthed but the third core insulated; and this, again, is different from the capacity between one of the cores and the other two connected together, &c.; there being a number of different combinations leading to different values of the capacity. For the relations connecting the various capacities, and the equivalent star-connected capacities which may be substituted for them so far as the "capacity current" of a three-core cable is concerned, our correspondent should consult

an admirable paper by Mr. A. Russell, on "The Capacities of Polyphase Cables," in the *Journal* of the Institution of Electrical Engineers, vol. xxx., p. 1022 (1901). If, further, he has a sound knowledge of advanced mathematical methods, and of German, he will find a very thorough investigation of this highly complicated problem in a paper by Lichtenstein in the *Elektrotechnische Zeitschrift*, vol. xxv., pp. 106-110, and 124-126 (1904). As regards the use of the copper strips, to which our correspondent refers, we may draw his attention to the following Board of Trade regulation regarding "extra high pressure mains," which furnishes an answer to the enquiry: "Extra high pressure mains for three phase supply will consist of insulated conductors laid together and enclosed in a lead sheath which must be permanently and efficiently connected with earth, and provision must be made either by copper strip under the lead sheath, or by steel wires outside it, or by bonding the lead sheaths of several cables together at joint boxes, or by other approved means, to ensure that the ground or any neighbouring electric line or conductor cannot become charged by leakage from the extra-high-pressure main."

Would you supply me with some information regarding negative boosters for tramways, or recommend some good text-book or magazine dealing with the subject?

The principle of a "negative booster" may be briefly explained as follows. In electric traction work, a definite limit is prescribed for the maximum "drop" or fall of potential along the track or rails, which serve as the return circuit for the motor currents, and are connected to the negative bus bar. If the prescribed limit were exceeded, serious electrolytic trouble would probably result, on account of the fact that when two points of the track are at an appreciable p.d., then since each point is in contact with the earth, and since the earth is a conductor, some of the return current will leave the rails and flow through the surrounding soil and any metal pipes embedded in it—causing solution of the metal at all parts of the metal surface where the current leaves. In order to keep this electrolytic or corrosive action within reasonable bounds, the drop along the track is not allowed to exceed a definite limit (seven volts). Suppose now that the drop is excessive. Then one method of reducing it is to use a "negative booster." This consists of a special generator (generally driven—at an approximately constant speed—by a shunt-wound motor) whose armature provides an E.M.F. of about the same order as the drop along the track. The positive armature brush is connected to the *negative* bus bar at the station, while the negative brush is connected to a cable which runs out to a suitable point of the track, and is there connected to it. The result of this arrangement is that while some of the current will return, as before, along the rails to the station, a large amount of it will flow to the point of connection of the negative booster to the track, and thence along the cable and through the booster armature to the negative 'bus bar. We now have currents flowing in opposite directions along the track, some towards the generating station, others away from it towards the point of connection of the cable from the booster. It is not difficult to see that the greatest p.d. between any two points in the track must now be very much less than it was originally. The booster action must be properly adjusted in order to secure minimum drop; for, if the booster E.M.F. is excessive, it may prevent any current from returning to the station directly by the rails, and this will result in an increased drop. But since the drop varies with the load, it follows that the booster E.M.F. should rise and fall in proportion to the load current. This rise and fall of E.M.F. is secured automatically by connecting one end of the booster field to the positive 'bus bar, and the other to a cable which runs out to a point in the overhead wire corresponding to the point of connection of the booster cable to the track. Automatic regulation of the booster E.M.F. will be secured provided that the booster field is well below saturation. In general details of construction, a booster does not differ from the ordinary type of generator, but is characterised by the relatively large size of its commutator.

Wiremen's Electric Light & Power Wiring Section — Artisans

Wiremen and Artisans should refer to the World's Electrical Literature Section for classified list of articles on subjects of importance to themselves.

Installing Electric Machinery.

By N. G. MEADE.

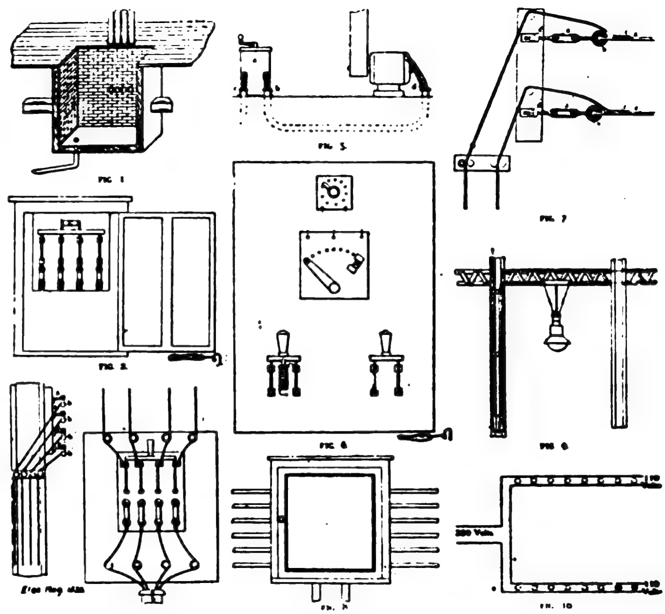
This article will be devoted to suggestions for light and power wiring in shops and foundries.

It is advisable to run underground conduits from the engine room to the centres of distribution for carrying the main cables. In multiple voltage plants, the manner of distribution varies with the ideas of the engineers in charge of the construction. Some engineers place the balancing set and controlling apparatus in the engine-room, and others locate it near the centre of distribution.

A combination of overhead and underground construction forms a flexible system. A well-designed manhole for multiple voltage systems is shown in Fig. 1. It is advisable to locate such a manhole wherever the underground system feeds the aerial cables. In the illustration, the four iron pipes which enter the manhole at about the centre lead to the switch cabinet, which is mounted on a convenient column. A drain pipe should be provided, as shown in the figure, for carrying off surface water that may percolate into the manhole.

An interior view of a switch cabinet, in which is mounted a quadruple-pole switch, is illustrated in Fig. 2.

Suitable lengths of about 4 × 4in. timbers are bolted to the side walls or columns of the building. Iron brackets attached to the wood pieces by coach-screws support the messenger wires of stranded galvanised iron wire. The messenger wire is connected to a strain insulator at one end and drawn taut by an insulated turnbuckle at the other. The cables are attached to the messenger wires by cable clips.



A neatly arranged connection for a motor is given in Fig. 3, where *a*, *a'*, *a''*, and *a'''* are the iron brackets and *b*, *b'*, b'', and b''' are the cables. The wires lead down the columns to a board on which is mounted a quadruple-pole switch, Fig. 4. From the switch the wires pass through an iron pipe, *b*, with an insulating bushing, *a*, to the controller. Fig. 5 shows the connections carried to the motor. The controller is indicated at *a*, the pipe from which the switch is shown at *c*, and *b* is a pipe leading to the motor. This pipe is also provided with bushings at each end, as shown at *d*.

Fig. 6 shows a well-arranged board, with back connections, for a constant voltage motor. A field rheostat is mounted upon the board, for varying the speed of the motor by field weakening.

Suitable devices for fastening the crane trolley wires are shown in Fig. 7. Turnbuckles, *a* and *a'*, with insulated eyes, *b* and *b'*, held by brackets, *d* and *d'*, support them. The wires, *e* and *e'*, are passed through the eyes and bent back and held in place with the feeder ends by a wrapping of copper wire, *c* and *c'*. The completed joints are then thoroughly soldered.

Fig. 8 illustrates a modern switch cabinet.

Most modern shops are structural iron work and masonry, consequently the wiring has to be thoroughly insulated from ground.

Fig. 9 shows the construction work for the arc lighting circuits in a large engine company's plant. The lamps burn two in series on a 220 volt circuit.

An arrangement for burning 110 volt lamps on 220 volt circuits is shown in Fig. 10.

The suggestions here given are based on practical construction now in use and may be safely followed.—*Power.*

[*Through pressure on our space, due to the Olympia Exhibition matter, this section is reduced this month. The Supplement has, however, compensating advantages.*]

Emergency Lights.

READERS will remember a brief description, accompanied by a diagram, of an emergency lighting system which we published in the July issue. With reference to that article we have received from Mr. H. McGillivray, of Newcastle-on-Tyne, a description of his own patent system for this purpose. It will be noticed on comparing the two that his outfit is very much simpler. The adjoining diagram shows the connections for an ordinary lighting system. The apparatus is also extensively used on tramway systems and electric railways. The battery is charged automatically from the line when not in use, and it will furnish current for several hours if necessary. A car equipment, including a 15 volt battery, weighs about 80lb.

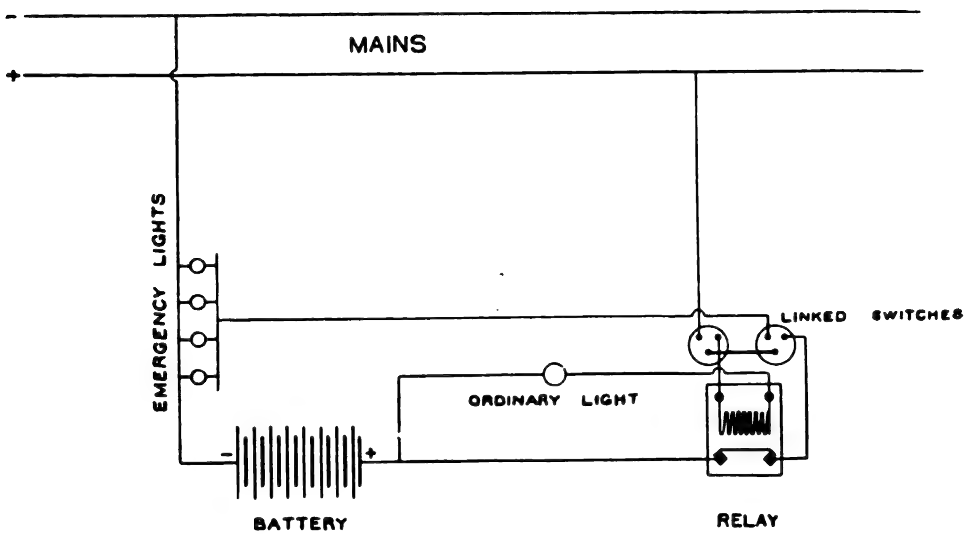


DIAGRAM OF EMERGENCY LIGHTING OUTFIT OF MR. H. MCGILLIVRAY.

The World's ELECTRICAL LITERATURE

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- *Waterside Station of the New York Edison Co. (*See* "Power" this month.) — *Elec. Wld. & Engr.* 9/9/05.
- Hydro-Electric Developments of the Ontario Power Co. — *Elec. Wld. & Engr.* 9/9/05.
- Electric Power in Mining and Metallurgy. S. Herzog. — *Elek. Bahen.* 14/6/05.
- *Mabb's Electric Elevator. — *Elec. Wld. & Engr.* 9/9/05.
- *A New Type of Motor Starter. — *Elec. Wld. & Engr.* 9/9/05.
- *Along the Niagara Toronto Transmission Line. — *Elec. Wld. & Engr.* 16/9/05.
- Bellingzona Hydro-Electric Plant. S. Herzog. — *Elec. Wld. & Eng.* 16/9/05.
- Erecting a Large Motor. W. Burns. — *Elec. Wld. & Engr.* 16/9/05.
- *New Power Plant of Brooklyn Rapid Transit Co. — *Elec. Wld. & Engr.* 23/9/05.
- *Electric Elevators. E. R. Carichoff. — *Elec. Rev.*, N.Y. 9/9/05.
- Bournillon Hydro-Electric Plant. C. L. Durand. — *Elec. Rev.*, N.Y. 16/9/05.
- Electrically-operated Lift Bridge at Duisburg. A. Gradenwitz. — *Western Electric.* 16/9 05.
- Walthamstow Electric Lighting and Tramway Undertakings. — *Elec. Rev.*, N.Y. 15/9/05.
- Storage of Blast Furnace Gas for Power Purposes. — *Elec. Rev.*, N.Y. 15/9/05.
- Transmission of Power by Alternating Currents. A. Still. — *Elec. Eng.* 15/9/05.

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- Atlanta-Marietta Single Phase Railway. — *Elec. Wld. & Engr.* 16/9/05.
- *British Law on Live Rail Accidents. W. V. Ball. — *Elec. Wld. & Engr.* 23/9/05.
- *The Single-Phase Railway in Practical Operation. — *Elec. Wld. & Engr.* 23/9/05.
- Street Railway System of the Borniage. A. Gradenwitz. — *Elec. Rev.*, N.Y. 23/9/05.
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- Christchurch Electric Tramways. G. Drummond. — *Try. & Rly. Wld.* 14/9/05.
- Street Traffic Regulation. W. H. Booth. — *Try. & Rly. Wld.* 14/9/05.

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- Gas Arcs and Electric. W. M. Kapus. — *Pac. Cst. Gas Ass.* 20/8/05.
- Magnetite Lamps and Mercury Vapor Arc Lamps and Rectifiers for Electric Light and Power Service. — *Ass. Edis. Ill. Co.* 13/9/05.
- Experiences with Tests on all Kinds of Lamps for the Past Year. Dr. C. R. Sharp. — *Ass. Edis. Ill. Co.* 13/9/05.
- Small-sized Carbons in A.C. Arc Lamps. G. N. Eastman. — *Ass. Edis. Ill. Co.* 13/9/05.
- Practical Operation of the Nernst Lamp. W. T. Morrison. — *Ass. Edis. Ill. Co.* 13/9/05.
- Calculation of Mean Spherical Candle-Power. L. W. Wild. — *Electn.* 29/9/05.
- Recent Progress in Electric Lighting as indicated by the Olympia Exhibition. F. H. Davies. — *Elec. Eng.* 29/9/05.

Telegraphy and Telephony.

Articles.

- *Adams-Randall High Power Telephone Transmitter Tests. W. Maver, Jun. — *Elec. Wld. & Engr.* 9/9/05.
- Incandescent Lamp for Intermittent Flash Signs. — *L'Ind. Elec.* 10/8/05.
- Wireless Transmission of Mechanical Action. Branly. — *Comp. Rend.* 26/6/05.
- New Wireless Station at South Boston. — *Elec. Wld. & Engr.* 16/9/05.
- Spark Gaps. G. F. King. — *Elec. Wld. & Engr.* 23/9/05.
- Development of the Postal Telegraph Company. C. P. Bruch. — *Elec. Rev.*, N.Y. 9/9/05.
- Directed Wireless Telegraphy. — *Elec. Rev.*, N.Y. 16/9/05.
- Siemens and Halske Printing Telegraphic Apparatus. E. Guarini. — *Elec. Rev.*, N.Y. 16/9/05.
- Recent Developments in Submarine Signalling. A. Gradenwitz. — *Elec. Rev.*, N.Y. 29/9/05.

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- *Electrical Nature of Matter and Radio-activity. H. C. Jones. — *Elec. Rev.*, N.Y. 9, 16, 23/9/05.

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- Aluminium as a Reducing Agent. O. P. Watts. — *Amer. Elec. Chem. Assoc.* 18/9/05.
- Standard Method of Measuring the Specific Resistance of Electrolytes. R. Threlfall. — *Amer. Elec. Chem. Assoc.* 18/9/05.
- Electrical Resistivity of Iron and Steel at High Temperature. G. Gin. — *Amer. Elec. Chem. Assoc.* 18/9/05.
- Electrolytic Process for Refining Silver. A. G. Betts. — *Amer. Elec. Chem. Assoc.* 18/9/05.
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- *Motor Rating Diagram. C. P. Macleod. — *Elec. Wld. & Engr.* 16/9/05
- *Approximation of the B. and S. Gauge, and of the Properties of Copper Wire. C. P. Macleod. — *Elec. Wld. & Engr.* 23/9/05.
- *Experimental Determination of Air Gap Reluctance. C. H. Smoot. — *Elec. Rev.*, N.Y. 16/9/05.
- Testing of High Tension Insulating Materials. C. Kinzbrunner. — *Electn.* 15/9/05.
- Ratio between Thickness and Dielectric Strength of H. T. Insulating Materials. — *Electn.* 29/9/05.
- Direct Current Machinery at Olympia. P. K. Friedländer. — *Elec. Eng.* 29/9/05.

Central Station Practice.

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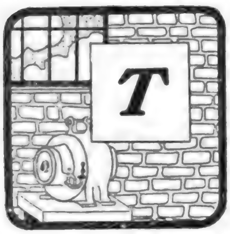
- *Regulation of Electric Rates in Massachusetts. A. D. Adams. — *Elec. Wld. & Eng.* 9, 16/9/05.
- Maximum Demand. G. S. Codman. — *Elec. Wld. & Engr.* 23/9/05.
- *Mercury Vapour Circuit Breakers. — *Elec. Wld. & Engr.* 23/9/05.
- Localisation of Cable Faults. H. Joseph. — *Elec. Rev.*, N.Y. 15/9/05.
- Central Station Design: An Exact Science. — *Elec. Rev.*, N.Y. 22/9/05.
- *Electricity Meters. C. H. W. Gerhardi. — *Electn.* 22/9/05.
- Prime Movers and Auxiliary Plant at Olympia. E. G. Beaumont. — *Elec. Eng.* 29/9/05.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

Some Motor Specialities of Clarke, Chapman, and Co., Ltd.



THE name of Messrs. Clarke, Chapman, and Co. has for many years been identified with the manufacture of open and enclosed type engines, dynamos, motors, electric drills, searchlight projectors, mirrors, lenses, &c., and they have had practically a unique experience in electric ship-lighting, having installed plants in vessels of every size and class. Among these can be included battleships, the largest of ocean-going passenger steamers, and steam yachts, not to mention innumerable smaller craft. The standard of excellency of these plants finds ample testimony in the fact that their direct coupled sets for this class of work are now in use on all the vessels of the leading steamship companies. We do not need to burden our readers with a list, as such details would be quite superfluous.

Special attention has always been given by the company to the development of electrically driven hoisting machinery, and some years ago a department was organised for dealing specifically with the many problems presented in this particular province. At the present time an expert staff is constantly engaged in the design and manufacture of all classes of lifting and hauling machinery for use in shipyards, dockyards, on railway sidings, shipboard, or in mines. The design of this apparatus calls for special notice at our hands, and interested engineers and users of such plant will observe many novel and valuable points in the various products of this department.

Electric winches for shipyard or warehouse purposes, boat hoists, coaling winches, ash hoists, mail hoists, and cargo winches for shipboard use are now built on standard lines, and for the purposes mentioned can be made to suit special needs.

They are built in various sizes for any loads from 3cwts. to 25 tons, and are designed with either a simple worm and wheel drive, combinations of worm and spur gearing, or are entirely driven by spur wheels. Either direct or alternating current motors are applicable for capacities of from 2½b.h.p. to 150b.h.p.

We illustrate in Fig. 1 a standard 5 ton winch, fitted with two speeds of gear, which is capable of lifting either 5 tons at 30ft. or 3 tons at 50ft. per minute. The motor is rated at 15b.h.p. at 220 volts with a temperature rise not exceeding 100° F. above that of the surrounding air after a continuous run of one hour on full load. Control is readily effected by a tramway type reversing and speed regulating controller, with magnetic blow out coil. Controllers of this pattern are more convenient than the exposed contact type, and are better adapted for more efficient control.

The motor pinion is raw hide and gears with a machine cut cast-iron spur wheel. The main wheel and pinion are cast steel, and the other wheels are of cast iron.

Two brakes are fitted to the winch, one on the barrel to control the maximum load, and another on the motor spindle for use in

emergency purposes. Clutches are fixed to the pinion shaft, and all operating levers are arranged in a convenient position at the motor end of winch. The controller and resistances are mounted on the winch bed, and the complete machine is very compact and self-contained.

Another important product is a line of electric capstans for hauling wagons on railway sidings or hauling ships into their berths at quaysides, after capstans for warships, warping capstans and capstan windlasses for yachts. In this particular Messrs. Clarke, Chapman are assisted by almost unique facilities for applying their designs in practice, consequently they can be relied upon to stand up to the many exigencies of what is always arduous service.

These capstans also are made in many sizes, the dead pull which can be exerted varying from 1,500lbs. to 20 tons. The motors for this class of work range from 5 to 50b.h.p., and drive either by simple worm gearing or a combination of worm and spur gearing. Fig. 2 depicts a capstan capable of exerting a dead pull on the rope of 10 tons at a speed of 30ft. per minute, and as the barrel is made in two diameters, a speed of 60ft. per minute can be obtained when the capstan is exerting a pull of 5 tons. The motor is rated at 35b.h.p. at 220 volts when running at about 600 revolutions per minute, and is operated by a barrel type controller having a foot pedal which projects above the capstan tank. The speed of the motor is reduced to that of the capstan barrel by means of worm and spur gearing.

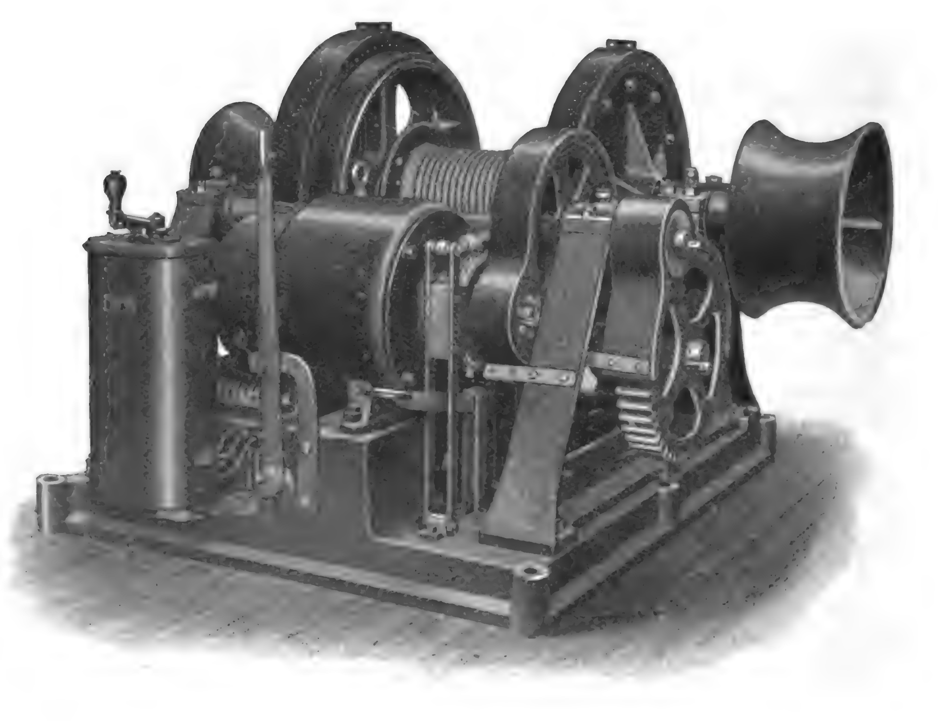


Fig. 1. Standard Five Ton Electric Winch, by Clarke, Chapman and Co., Ltd.

The worm is double threaded, and is forged solid with its spindle and coupled directly to the motor shaft. The worm wheel has a machine-cut gun-metal rim securely bolted to a strong cast-iron centre. This gear runs in a substantial cast-iron box filled with oil.

The necessary bearings for the worm shaft are cast into this box, and a special roller bearing is fitted to take the end thrust from the worm. A bearing is bolted on to the worm case in which the worm wheel

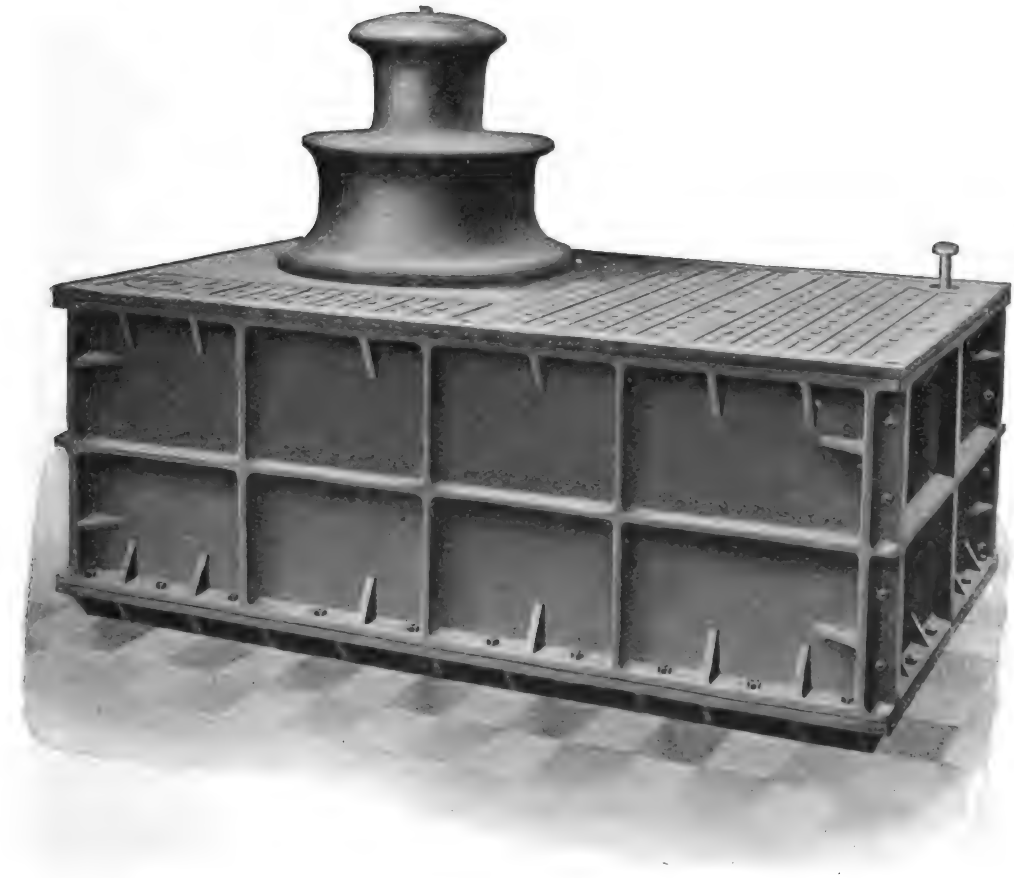


FIG. 2. STANDARD ELECTRIC CAPSTAN, 10 TONS CAPACITY, BY CLARKE, CHAPMAN, AND CO., LTD.

shaft revolves, and on the lower end of this shaft is keyed a spur pinion which gears with a wheel on the capstan main shaft. All the gearing is of cast steel.

The motor, controller, and gearing are enclosed in a strong cast-iron tank which is quite able to take in itself, all the strains due to the ten tons load. The tank is cast in sections, all of which are carefully planed and secured together by turned bolts, all the joints being made watertight. A magnetic brake was fitted to the capstan illustrated, but this was found unnecessary for ordinary capstan work, and it is only supplied when specially specified. This particular capstan was installed some years ago on a dock wall, and is in constant use for hauling ships about; it has been working satisfactorily for some years.

Among other important capstan installations carried out by Messrs. Clarke, Chapman, special mention might be made of those installed on the Prince of Wales' Piers for the Dover Harbour Board. These were similar in design to that already described, save that the capstan head was of one diameter and the gearing arranged for and tested with a direct pull of twenty tons on the rope.

Fig. 3 illustrates a group of friction driven hoists manufactured by the firm.

This type of hoist has been successfully applied to coaling warships, raising ashes from stokeholds, and also for dealing with mails and light luggage on ocean-going liners, or for quick warehouse whips. The standard sizes vary in power from 3cwts. to 1 ton, the motors developing from 2½ to 26b.h.p.

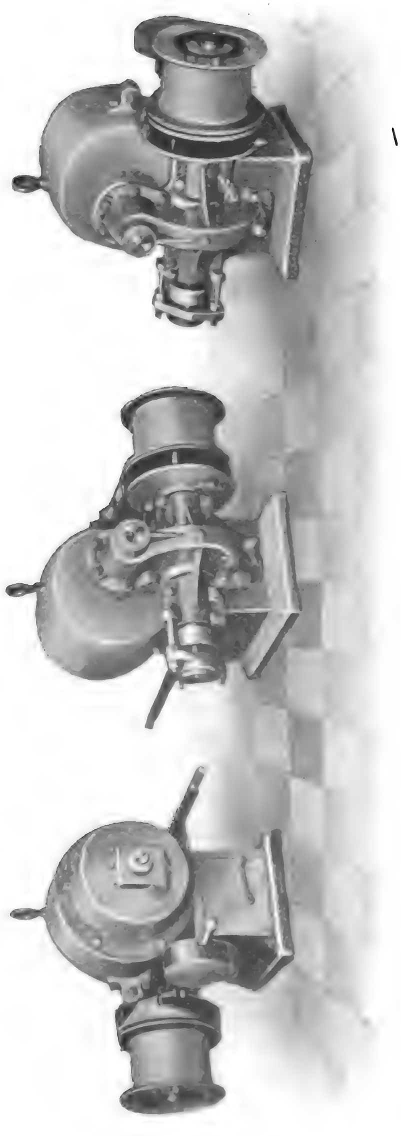


Fig. 3. Group of Clarke, Chapman Friction Electric Hoists.

The motor is a constant speed machine and continually running, and is operated by a starting switch fitted in the motor casing at the rear end. The speed reducing gear consists of a worm and gun-metal wheel, the shaft of the latter carrying the drum and friction cone. The drum is loose on the shaft and has at one end a bearing for the cone and at the other end an automatic brake. The cone is attached to an internal shaft which moves endways under the influence of a screw and lever. When hoisting it is necessary to raise the lever slightly, and the cone engaging with the barrel causes it to rotate and lift the load. When the latter reaches the required height, the lifting lever is returned to the horizontal position and the brake takes charge and holds the load suspended. To lower, the brake lever is raised and held up while the load descends.

Among the many uses to which electric motors are being put, mining machinery takes a very important place, and Messrs. Clarke, Chapman, and Co. are paying particular attention to this branch of engineering industry. They have installed a number of machines both in this country and abroad, among these being winding engines, single drum main rope haulages, endless rope haulages, and main and tail haulages, varying from 10b.h.p. to 220b.h.p. and arranged either for direct or alternating current.

Sun Electric Fans.

The Sun Fan Company, Bradford, have devoted considerable time and attention to the design and construction of fans and motors, and their object has been to produce the best possible apparatus of the kind, thoroughly efficient and reliable. There is, however, no finality in excellence, and whenever it is found that improvements can be made, after thorough trials in their works, they are introduced. The fans are designed to more large volumes of air at moderate speeds, this being especially desirable in ventilating work, where noise is objectionable. Special fans and motors are built to overcome any resistance required, as in exhausting from or blowing through ducts, or for drying purposes, and other requirements.

The success of any installation must necessarily depend very largely on the right application of the apparatus, and to achieve the best results the ability and experience of specially trained engineers must be brought to bear. We understand that this department has the personal attention of a highly qualified expert, who has had close on twenty years' successful experience in the construction and application of fans for all purposes. The Sun fan is the result of the inventor's long experience in the making, testing, and application of fans of this type for all purposes for which they are suitable.

The Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. IV. No. 5. (23rd Issue.) LONDON. NOVEMBER 29, 1905.

The World's Electric Progress.

An Unparalleled Issue.

THE reception accorded our October issue containing the souvenir of the Olympia Electrical Exhibition constitutes a record in our history. It is unparalleled by anything we have yet done. Further we do not believe that any engineering or technical journal in this country has ever secured such a sale. At the moment of writing so extensive has been the demand that 20,000 copies is insufficient to meet requirements. We are still receiving orders for large quantities of the souvenir from electricity supply undertakings, both municipal and company, throughout the United Kingdom, and we shall announce later the astonishing total figures touched by the issue. Golden opinions as to the style and get-up of the number have reached us from all parts, advertisers, subscribers, and casual readers alike speaking highly in its praise. So great was the call for our first edition that we were unable to supply a large repeat order of W. H. Smith and Sons, and this in itself is striking evidence of the popularity of the issue. Indeed our best anticipations regarding the issue have been more than realised, and we feel that we have accomplished to the full the task we had set ourselves. In the present instance we have been able to meet the wishes of our zealous and enterprising supporters, and our advertisers have and will continue to reap the benefits of the phenomenal circulation which we have been enabled to give to their specialities. For the rest we have to say that we hope with our New Year number, which will celebrate the third anniversary of THE ELECTRICAL MAGAZINE, to eclipse even the exceptional success of the Olympia Souvenir.

Switchboard Death-Traps.

IT was quite a common thing with the older high tension stations to read of electric shock fatalities in the bus-bar chambers of the switch gear. A great outcry arose for controlling apparatus which primarily safeguarded the operator and rendered a fatal shock impossible, except to those suicidally inclined. The cellular switch gear, originated by Mr. Ferranti, became at once popular, and has been widely employed with infinite advantage to electricity supply, both in this country and the Colonies. Although bad burns have been received on boards of this class by careless operators, in no instance can a single shocking fatality be laid to its charge. The design so completely fulfilled its object that it has rightly been termed "fool-proof." In the interests of employés in high pressure stations its adoption should have been made compulsory, but engineers with an economical turn of mind have preferred to use cheaper and consequently more dangerous apparatus. Within the last three months deaths have occurred in three cases from shocks received on gears in which "high tension chambers" figured. Now this particular design is fatal to the interests of safety. The fact that the chambers are of restricted dimensions, and contain charged metal frequently exposed on three sides, makes them veritable death-traps even for the experienced. It is little short of criminal that such designs should ever find their way out of the drawing office, as a bitter experience affords conclusive evidence for their condemnation. The cellular gear has had many imitators, but in the essence has never been improved upon and, from what we can see, never will be. It is on

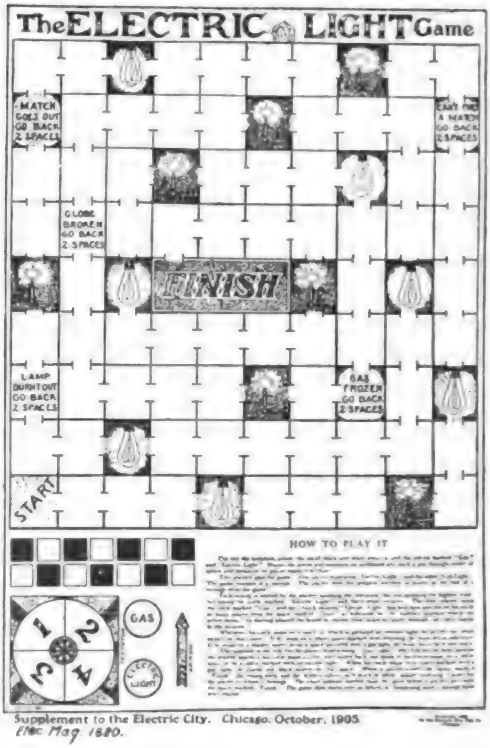
mongrel designs purporting to be cheaper that deaths occur and accidents continue, which might be avoided were properly planned apparatus installed.

Central Station Advertising.

The Olympia Exhibition has probably strongly impressed upon central station engineers the necessity for some form of advertising in connection with their "sales" departments. Certain it is that the days of economic refinements in electricity works have passed, and determined efforts must be made to get in new business. Our gas competitors are always aggressively militant, and they profit by the circulation of enterprising literature eulogising the splendours of gas. In the same way customers can be attracted on to the electricity mains, and without anything like the same difficulty. Canvassing departments are in operation with many stations, but they frequently fail or fall short of the mark for want of what we might call a "publicist," a technical journalist who can get out vitalising literature. Canvassers are drawn from the wrong class, and can only approach a few possible clients a day. They need to be good technical men, and should have the way paved by judiciously compiled pamphlets. They can then "get their fingers in" somewhere. We think that any such movement among British central stations will bring about the establishment of organised publicity methods for systematic campaigning against the gas interest. The circulation of our Olympia Souvenir among central stations persuades us that engineers are now no longer indifferent to the necessity of constantly keeping the merits of their department before the public in their districts. We have frequently pointed to the enterprise of American supply concerns in this direction, and reproduce the adjoining illustration as an example of the extent to which they consider it is necessary to go to impress the public with the value of electric lighting as compared with gas. This is of course a special and almost extreme example, and must not be taken as typical of all the matter of this class issued. We have seen some very beautiful pamphlets which have emanated from American central stations, and judging by the eulogies of this kind of literature from station managers it is not issued in vain.

To Dispel Doubt.

JUDGING by the hub-bub in electrical circles on the subject of electricity *v.* gas for street lighting, the calumnious statements regarding the former are likely to find immediate refutation and to be received as they deserve in the proper quarters. The City of London's decision to replace its antediluvian arcs by high pressure gas burners has been come to without a complete knowledge of all the facts, and so swiftly have the cudgels been taken up on behalf of modern



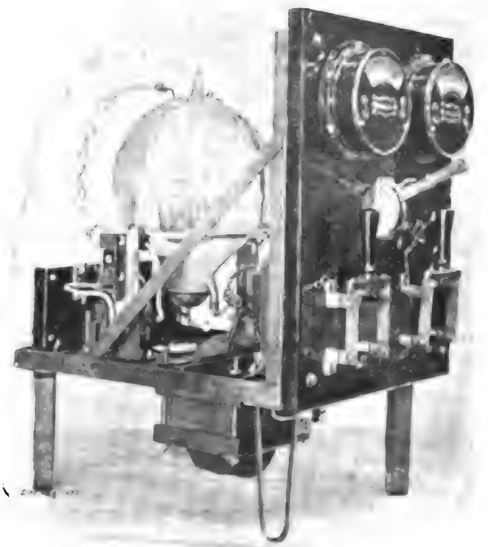
A PARTICULARLY VIRILE SAMPLE OF AMERICAN CENTRAL STATION PUBLICITY METHODS.

electric lamps that the experiment loses its significance before it is actually made. The gas interest on the strength of this so-called triumph of the incandescent mantle over the arc has stooped, and very low at that, to sow the seeds of dissatisfaction in other centres enjoying the advantages of electric street lighting. A gilded restatement of the facts does not describe its methods of giving general publicity to the circumstances. Not content with employing false comparisons whereby to boost the so-called merits of gas for lighting main and bye

thoroughfares, it is considered just and honourable to circulate grossly libellous statements regarding proceedings which were themselves predominated by an obviously unfair bias in favour of gas. Tricks of this kind may be very smart, but they always recoil on those who use them sooner or later. In this instance it is sooner, and very much so. From all quarters overwhelming evidences of the impossibilities of placing the best known forms of street gas lamps on a competitive basis with the new flame electric lamps have poured into the columns of the technical and lay press. Despite frantic and doubtless unscrupulous efforts to wrest the street lighting contract for the City of Westminster from the St. James's and Pall Mall Electric Lighting Company, that undertaking has retained its hold on what is its legitimate property by superior right alone. At Croydon, a proposal to install an experimental set of gas lamps which were to sweep out the electrics has been treated with scorn by the Corporation, and at Chelmsford some 300 Nernst lamps are, after a severe tussle with the gas interest, to do lighting service in the streets for the next few years. We hope the gas companies will not point to Kingsway as a sample of their much-vaunted high pressure lighting. Our offices stand at the northern entrance to that thoroughfare and we are constantly treated to the dismal spectacle of a green and sickly glare feebly attempting to rival the golden rays of a few flame arcs on the Holborn Restaurant. A noble public highway bearing so regal a name, too, has been prostituted by the erection of the things doubtless known as incandescent arcs for lighting purposes. The pity of it is they are there for five years, but we very much doubt their stayimg powers. The Westminster City Council will find itself before long in charge of a magnificent street lined with superb buildings but bedight with a row of puppet lanterns aping the brilliance of modern light sources, and hopelessly failing in the attempt. The gas companies are welcome to the fruits of their labours.

One-Phase Traction Progress.

THE recent decision of the New York, Hartford, Newhaven Railway Company to adopt one-phase locomotives of a heavy type for a portion of its system marks a decided step in advance for this much-abused section of electric railroading. The fact that these locomotives can also be operated with continuous current, and will be run over a portion of the third rail system of the New York Central, which has adopted this method on an extensive scale, has raised quite a storm of opposition from the engineers of that Company, the chief of whom is the eminent and much-respected Mr. F. J. Sprague. A very full abstract of that gentleman's views of the situation is given in the Transport Section this month, and to this we refer our readers for fuller details. The best that Mr. Sprague can say in reply, however, is that he is "a better friend of rational A.C. development applied in a rational way to railway operation, while maintaining that the limit of D.C. operation is by no means reached, than a majority of those who sing its praises on a single strident but ofttimes unmusical note — even if I am unwilling to see its present injection into the densest section of the train movement of two great railway systems with almost inevitable adverse consequences." The situation may be compared to that which might arise if the Great Central Railway announced its intention of running D.C.A.C. locomotives over the tracks of the Metropolitan Railway Company, on whose lines it has running powers.



MERCURY VAPOUR RECTIFIER, A FORM OF WHICH HAS BEEN SUGGESTED FOR ELECTRIC TRACTION WORK.

Lighting Standards and Lighting Progress.

STANDARDISATION is a good thing when judiciously applied, but more than ordinary judgment is required, and even with this it is doubtful whether the benefits derived are as great as they are supposed to be. Standardisation of dynamos and motors is one thing, but standardisation of lights is quite another. In the first instance, it is essential to the satisfactory practical embodiment of a well-founded principle, but in the second, the basis of standardisation is nothing like as stable, consequently difficulties arise in the selection of a suitable foundation from which to make a start. Electric lamps, as we now know them, are eminently satisfactory in themselves, but, as recent developments have shown, are subject to possibilities of supersession at a more or less distant date. In the suggestion put forward by Mr. Leon Gaster in a recent issue of the *Times Engineering Supplement* for the adoption by the National Physical Laboratory of a primary standard of light, there is much that is valuable, but a great deal which is difficult of accomplishment. The National Physical Laboratory, in addition to setting up this standard, is to undertake the testing of lamps for municipalities, companies, &c., on a basis which shall be settled by a representative committee of manufacturers and central station engineers. We quite agree that a generally recognised standard of light would tend to improve the efficiency of electric lamps, but it is difficult to conceive of competing manufacturers agreeing to submit their goods for test to a common central authority. The comparison between different makes of lamps thus rendered possible might be interpreted as a recommendation of those types which best fulfilled the requirements of the standard. Although this has everything to recommend it, it savours too much of autocratic dominance of their goods to meet with the general approval of the lamp makers. Manufacturers, as far as we can see, are perfectly willing to be guided by the dictates of such a body as the Engineering Standards Committee, but they may claim as their special privilege the right to see that those standard requirements are embodied in the apparatus in question. Mr. Gaster's suggestion clearly stamps him with the mark of an optimist of the first water, but we think his ideals in failing to find universal approval meet with the only response which a keenly competitive section of the electrical industry can give. The adoption of a standard may, however, be not difficult if the right to test is retained by the lamp makers.

ONE OF THE BUILDINGS AT THE PORTLAND (U.S.A.) EXHIBITION, ILLUMINATED AT NIGHT WITH MANY HUNDREDS OF INCANDESCENT LIGHTS.

A New Students' Scheme.

THE Students' Section of this journal was at its inception welcomed as a highly valuable feature, and one likely to prove permanently useful to students and beginners in electrical engineering. From the many letters which we have received from students in all parts of the world the results have quite equalled our anticipations, so much so indeed that we have made arrangements to considerably enlarge the scope and purview of the section. We take this opportunity of inviting the co-operation of students in making the section even more valuable, both to themselves and their *confrères*. In place of the usual signed articles and other matter which has previously made up the section, we propose publishing original essays or short articles from students themselves upon the various branches of electrical engineering. At the present moment we think it better that students should select their own subjects, confining themselves to the limits of length which we shall subsequently announce. It may be found necessary to fix the subject to be dealt with every month, but this is a detail which can be best settled later. We shall initiate this modification with the January issue of next year, and those students who will participate in the scheme should get to work at once on the article or articles which their knowledge best fits them to prepare. The length of these we will fix, as a preliminary, at 500 words and a maximum of three sketches. In the choice of a subject the sections of this magazine, and their sub-divisions, can be taken as a guide, and for the first number only those articles coming within this range will be considered. The work will be placed upon a competitive basis, and prizes, to be announced later, will be awarded every three months. The portraits of successful authors will be published with their matter each month as an additional inducement for students to compete. A perfectly impartial judgment will be given, and the decision of the Editor of the section will in every case be final. We are induced to give students this opportunity of airing their views, as it will encourage many young fellows to take a keener interest in their work, and enable them to display their talents to equal advantage as in the technical school or examination room. All matter for the January issue should reach us not later than the 1st of that month.

Phase Regulators and Their Possibilities.

THE idea of performing by electrical means many of the operations necessary to the proper conduct of power and sub-stations has existed ever since commercial electrical engineering had its being. Slowly but surely that idea is taking shape in practice, and if its embodiment proceeds at anything like the present rate of development it will soon play a very important part in the management and control of electricity supply undertakings. As things are at present the power house, to take an instance, comprises a number of units which when once set in operation are practically automatic. The prime movers are self governing, and the generators are even better in respect of this, and their duties in actual service are watched over to a very small extent by the man in charge. There does not seem to us the least reason why this small amount of supervision could not be carried out by some automatic means. The manufacture of highly efficient relays, time limit devices, and solenoid operated switch gear clearly points to a marked tendency to relegate operations at one time performed by hand to the care of electrically actuated devices. There needs but the introduction of some instrument, not necessarily delicate, but possessed of certain discriminating properties, to effect the automatic combination of the various items which go to make up an electricity supply system. In this particular we recommend to our readers' notice an article which we publish this month in the Electrical Design and Manufacture Section. This will be found highly interesting, and its perusal will give some little idea of the possibilities lying before the development of such apparatus in practice. Referring to the apparatus itself, assuming correct excitation on the generator, the phase relation and distribution of the load currents flowing from either machine will be dependent upon the angular speed relations of the machines. If the contacts are adjusted so as to clear the contact arm when the current phases are in unison, then, if from any cause either engine should surge ahead or behind its companion, the resulting phase displacement of the generator currents and consequent movement of the contact arm will start in motion the small motor, its rotation being such as to close the valve of the leading engine and open the valve of the engine which is tending to fall behind. Thus a speed-equalising effect is introduced which

tends to maintain the initial load conditions for which the regulator was adjusted. It will be apparent that actual operating conditions may require combinations of the above applications; thus it might be desirable to maintain a group of several rotary convertors in phase union with each other. The "master machine" of the group, however, would determine the power factor at which all the rotaries would tend to operate. Different methods have heretofore been suggested for meeting one or more of the above applications. It is believed, however, that the particular mechanism proposed embraces several points of novelty, especially the idea of utilising a "master machine" to which other machines on the circuit may be cophased.

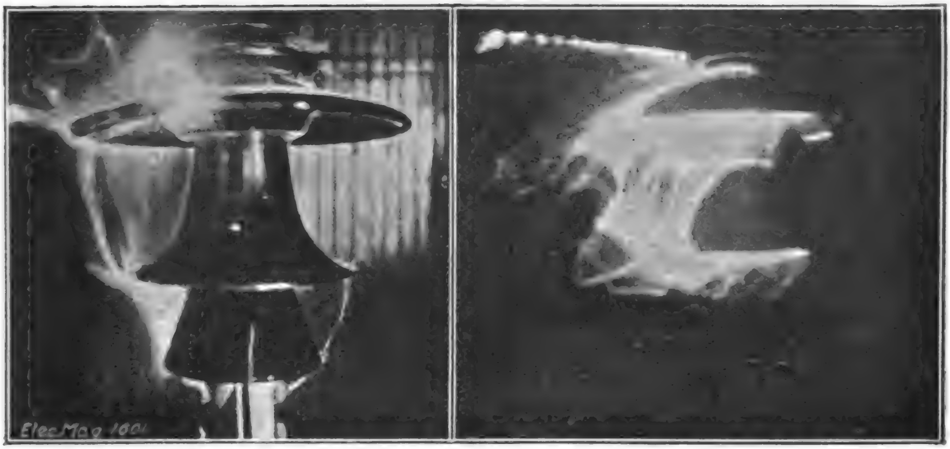
London's Electrified Underground.

PASSENGERS on the new electric trains now running beneath London's streets have been treated to various unrehearsed incidents since the new service began. The lay Press always make the most of mishaps no matter where they occur, and both the Metropolitan and District lines have received their full share of attention at the hands of the "great creators of news." The various accidents which have occurred are, of course, annoying in their way and tend to temporarily discourage traffic, but they are not the result of inherent defects of the system, nor should they in any way destroy public confidence in the new service of trains. The daily Press cannot, of course, be expected to qualify its reports of derailments, flashings of the third rail, and occasional gas explosions with information which, if obtained from technical sources, would tend to allay public fears. Passengers rushing wildly from a station on the least pretext are not the best form of advertisement for a railway company, and still less so are the fiery accounts which the daily papers serve up to their readers. The management of the respective companies should by this time be inured, and doubtless they are prepared to live down the effects which a too eager newspaperdom is likely to have on their traffic receipts. Both lines deserve the unqualified support of London's travelling public, and that appreciative spirit which Britishers alone know how to express would be fully evident were the difficulties overcome in the conversion of the line from steam to electric traction more widely known.

Dark Flashes of Lightning.

AN interesting point in connection with electrical discharges was recently raised in the columns of the American *Electrical Review*. A correspondent submitted a photograph of a lightning flash taken by the usual means adopted in such cases. We reproduce this herewith, and it will be noticed that in addition to the ordinary luminous streak there is a number of dark lines radiating from the neighbourhood of the flash itself. These have been somewhat emphasised in the reproduction, otherwise they would hardly have been visible. No satisfactory explanation could be offered for the presence of these dark flashes, as they were termed. The matter was subsequently followed up by the Locke Insulator Maunfacturing Co., who sent in a number of photographs of insulators under test at extra high voltages. We reproduce four of these as being of exceptional interest, and in one or two instances it will be noted that the dark flash has occurred in a somewhat similar way.

TYPICAL LIGHTNING FLASH, SHOWING DARK FLASHES AT THE SIDES.

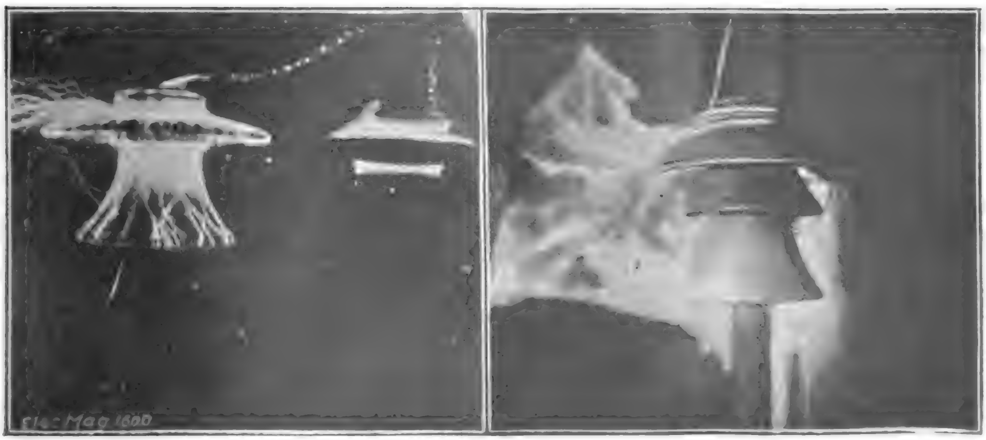


High Voltage Insulators Tested for "Dark" Flashes.

Our contemporary in remarking upon the phenomenon referred to an experiment conducted by Lord Kelvin from which he supposed the effect was due, in the case of the human observer, to retinal retention. In the case of the photographs some experiments of Clayden and Lockyer showed that a sensitive plate after being exposed to a lightning flash, when subsequently exposed to diffused light or a second flash reversed the image impressed by the first discharge. This explanation was, however, disputed by the correspondent in question, who exposed plates for extended periods to lightning flashes on which the dark flash could not subsequently be traced.

The Siege of London.

The list of Power Bills for the supply of electricity in bulk to Greater London has assumed quite unlooked-for proportions, and if all the proposals are sanctioned the Metropolis will attract those of its runaway manufacturers who have sought or are seeking the country for relief from rate oppression. Both the London companies and Borough Councils are in the running, the latter in the person of the ambitious L.C.C., which has none but the vaguest of proposals to work on. The Additional Electric Power Supply Co. is to do all its generating at St. Neots, some 50 miles away, and transmit by overhead and underground



High Voltage Insulators under Test.
The Dark Flash can be distinctly seen in the right hand specimen.

mains to the city areas where there will be no competition with the existing concerns. The Administrative Company's Bill is also down again, but with the near prospect of a political upheaval it appears doubtful that any of the suggestions will receive legal sanction for many months yet. Meantime, the London supply authorities must wake up and get all the business they can.

THE WINDMILL.—IX.

Operated by DON QUIXOTE.

The Moral Influence of Electricity.

ELECTRICITY has been studied in many aspects—as an infant, a dual fluid, an ætheric vibration, and as "that subtle, mysterious potentiality evolved in bygone æons out of chaotic Cosmos" (I quote from the columns of a non-technical organ); but, so far as I can ascertain, nobody has given due prominence to electricity as a moral force. This is regrettable, because everything, from Zionism to the Pinerotic play, is a great moral force nowadays. An Institution paper upon the subject would be of profound interest, and would probably reach "the hidden depths of many a heart" that fails to syntonise with disquisitions on Duddellographs or to melt at the fusing-point of curiously compounded alloys. In the meantime a few inadequate remarks on this great subject may be permitted.

In the first place, the intending electrician must renounce the world with its wicked ways, forasmuch as he will never have enough money to go the pace of a healthy snail. I do not think I shall quickly forget the remarks once made to me by a branch manager of an electric manufacturing firm whom I incautiously congratulated on the sphere of influence in which he moved. He replied in an oppressively slow and deliberate manner, ejecting each word with fearful vehemence. "I'm expected to make myself happy and familiar with twelve town councillors and thirty men of influence in this consigned locality, each of whom comes to my office, wastes my time (I'm allowed one fourteen-bob office boy as staff), and smokes my cigarettes, which the firm don't allow in petty cash. I get four quid a week to live handsomely and go to dances on; and if I fail to exert social influence for the benefit of ————'s motors I get the sack. See?

In the next place, the electrical engineer must love work for work's sake. And Work, as known to the electrical engineer, is a buxom damsel of the very largest dimensions. The junior engineer gets tamed into a due appreciation of the loss of the Sabbath by a course of central-station shifty-engineering. Even if by any chance he gets from the schools to the consulting office—the antipodes of the central station—he must, unless he be a shirker, outstay the typist and the charwoman. He carries home the balance of his work in a bundle, and happy is he if, on retiring at two in the morning, he is not hagridden in his dreams by the worries of the day.

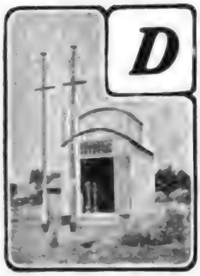
These two items, perhaps, may be accounted lightly. A healthy man is not really in need of high society: he can cut his coat according to his cloth. Moreover, he can so form his mind that work becomes his joy—the pivot of his existence. Yet the fact remains that the electrical engineer is not as other men who turn to billiards or Browning to relieve the *ennui* of their evenings. He becomes—in practice, and perhaps unconsciously—of the cult of the Buddhist, his entity being absorbed in the All-Pervasion of electrical engineering.

Thirdly, electrical engineering is the finest moral Sandow treatment of modern times. The man of one talent had better wrap it in a napkin and bury it—and himself alongside it—rather than become an electrical engineer. Wholesome breadth of mind—the broader the better—adaptability to any form of occupation, and imperturbability at any change of circumstance—these are the mental muscles of the electrician. He must always be prepared for new points of view—new taxes on his powers of imagination and organisation. He must be everything meant by "a man of affairs." And, in electrical engineering, affairs are Affairs.

Finally and most forcefully, electrical engineering as a moral force is most potent in the direction of absolute truth. I do not propose to say much on this point, as he who would talk of the truthfulness of the electrical engineer should speak with the tongue of men and of angels. But I have just been reading a brochure concerning an electrical apparatus—I will not further define it—and would simply remark that the subject of electricity as a moral force occurred to me as I read.

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Hydro-Electricity in India.



DESPITE its extended periods of drought and generally hot climate, the Indian Empire is essentially fitted for hydro-electric power developments. Bordered as it is by lofty mountains, including the highest in the world, its resultant complement of rivers and streams provides ample opportunity for the conversion of their natural energy to electrical energy and its transmission to points at which it can be economically distributed and used. When one thinks what has been done in other great countries possessed of expansive water-bearing areas it is not difficult to conceive of a transmogrified Asia living under the blessings conferred by electrical energy thus generated from practically boundless natural resources. An electrical engineer has only to look closely at a map of Asia to conjure up some such result of his speculations in this direction.

The largest hydro-electric plant operating in Southern Asia is on the Cauvery River at Sivasamudram. A fall of nearly 400ft. is here taken advantage of, and an average of approximately 12,000h.p. is available during the dry season. At times of the monsoons this reaches a maximum of 200,000h.p. We understand from the *Electrical Review, N. Y.*, which recently devoted four special articles from the pen of Mr. A. C. Hobble to the plant, that the first installation was completed after two years of difficulty and annoyance, in June, 1902. It was designed to furnish power over a 92 mile transmission line to the Kolar gold fields, where it is almost entirely used for mining operations. Extensions representing an additional 3,610k.w. output have recently been completed, and the present generator capacity is approximately 8,000k.w. This extension includes a 60 mile 35,000 volt transmission line to the city of Bangalore, which has 180,000 inhabitants. The entrance to the intake canals is three-quarters of a mile above the falls, and the power house is located

Cauvery Falls, near Village of Sivasamudram.

about one mile below them. The two canals are about three miles in length and follow the natural contour of the country. The average flow of water in these canals is from 2 to 3ft. per second. These channels finally immerge at the station forebay from which the water is piped to the generating sets. The water might have been brought by a much shorter route in wooden flumes, but local engineers consider the proposition unsound on account of the depredations of white ants. The station at present contains eleven 1,250h.p. 720kw. units, the turbines being of the horizontal impulse type direct connected through a rigid coupling to the generators. Special hydraulic governors have been fitted by which the water pressure in the pipe is kept within 5 per cent. of normal under sudden variations of load. For a 10 per cent. load variation only 2 per cent. speed change is guaranteed and only 8 per cent. change in speed for 50 per cent. variation of load. In conjunction with this governor an emergency relief valve is provided which quickly opens and allows the surplus or impact water to escape should the load be suddenly thrown off the generator. This valve closes slowly against oil pressure as the load assumes its normal value. It is interesting to note that after three years' service the steel cups of the impulse wheel show an almost imperceptible amount of wear despite the presence of grit in the water at certain periods of the year.

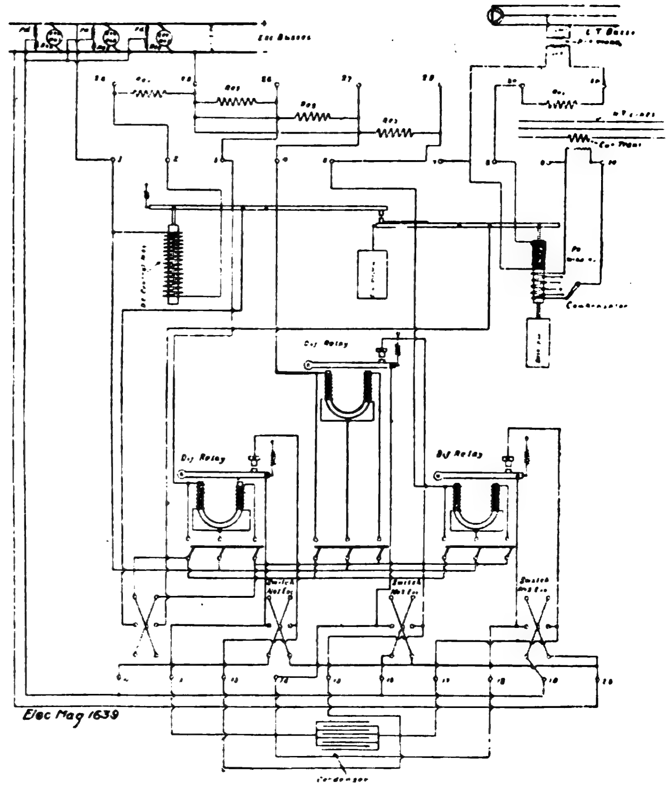


Diagram of Automatic Regulator as used in Cauvery Falls Power Plant

In the new plant automatic voltage regulators have been installed, and owing to the wide range of voltage to be controlled two regulators are arranged in multiple, one operating on the lower range and the other on the higher. The regulators are in the exciter circuit and one, two, or three exciters can be run singly or in parallel with the one regulator. Although the line voltage at the transmitting end varies approximately between 29,760 and 37,000 from no load to maximum, the voltage in the power transforming station at Kolar remains practically constant at 29,702. At normal load the line loss is practically 15 per cent. A special system of anchorage at sub-stations has been provided and wind guards have been found necessary to keep out the rain during the monsoon weather. Transmission lines are run on composite poles each comprising a heavy 7in. wrought iron socket into which is let a 17ft. length of Jarrah wood, thus making a pole 28ft. 3in. long. The poles are spaced about 130ft. apart and are set 6ft. into the ground. Some trouble has been experienced with these poles from dry rot, and in the Bangalore transmission line wrought iron poles with iron cross arms are being used. Section houses are provided en route for cutting up the line into three divisions when required for repairs. At Kolar current is distributed at 2,300 volts and is used for various purposes about the mines. Some 3,650h.p. is employed for air compression, 2,900h.p. for stamping mills, and approximately 500h.p. for small hoists, pumps, and stone

breakers. Motors rating from 100h.p. up to 400h.p. are wound for 2,080 volts and smaller sizes for 220 volts. At the transforming station a 1,000h.p. synchronous motor is used solely for phase control or power factor regulation of the system. With proper control of the field excitation of the motor assisted by that of the three synchronous motors used for power purposes, it is possible to operate with normal load near unity power factor. This phase control of long transmission lines is very important as low power factor means greater line lost, heavy overload armature current for full output of generator and over excitation of the generator fields, in fact, low efficiency on the whole system. Experience with rubber-covered cables in tropical climates has proved them to be unsatisfactory, and it is stated that H.T. wires and cables insulated with good quality varnished cambric give a much better result. It is expected that the present steam winding engines employed in the mines will be replaced by large motor-driven plants, as coal at 25s. per ton is an expensive article for motive power. £18 per h.p. year is at present charged for electrical energy, and in three years this figure will be reduced to £10. As considerable economies are effected by the former figure the lower rate will mean an enormous saving to the mining companies.

Mr. Hobble, in concluding his interesting article, states that since the completion of the overhead scheme electrical development in India has been given a marked impetus, and several hydro-electric projects will be realised in the near future. Several Indian districts are rich in iron, aluminium, and other mineral deposits, but the prohibitive price of fuel and transportation difficulties have rendered these impossible of development. It is only by the use of transmitted power that industries of this character can be stimulated and put upon a sound commercial basis.

Improvements in Power Plants.

SELDOM now are reciprocating engines recommended for very large units, and practically never for the driving of high duty sets in plants of new design. The story is now so oft repeated of large stations carrying out extensions with turbines, or building new with similar types of prime mover, that one is apt to desire relief from the monotony of it. The fact cannot however be ignored that the steam turbine is now a highly efficient, economical and reliable machine for the driving of dynamos, and its installation has become a matter of necessity rather than of policy.

A striking increase of the tendency to adopt turbines is afforded in the latest plans of the Philadelphia Rapid Transit system, which provide for a turbo-generator station of 50,000kw. ultimate capacity. Increased traffic with heavier cars necessitated the erection of a temporary plant at Wyoming Avenue, but this was extended with horizontal turbines, and is now a permanent institution. A plan of this station is shown in Fig. 1. The boiler equipment includes five batteries.

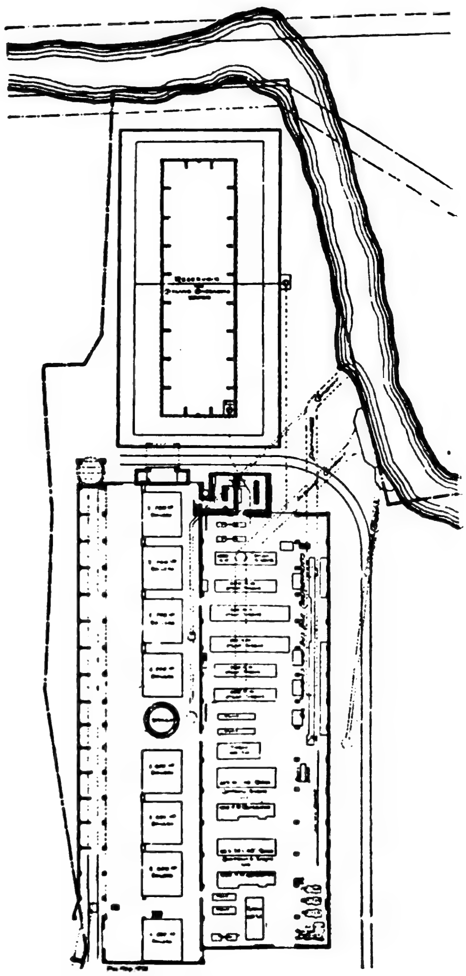


FIG. 1. PLAN OF WYOMING AVENUE STATION.

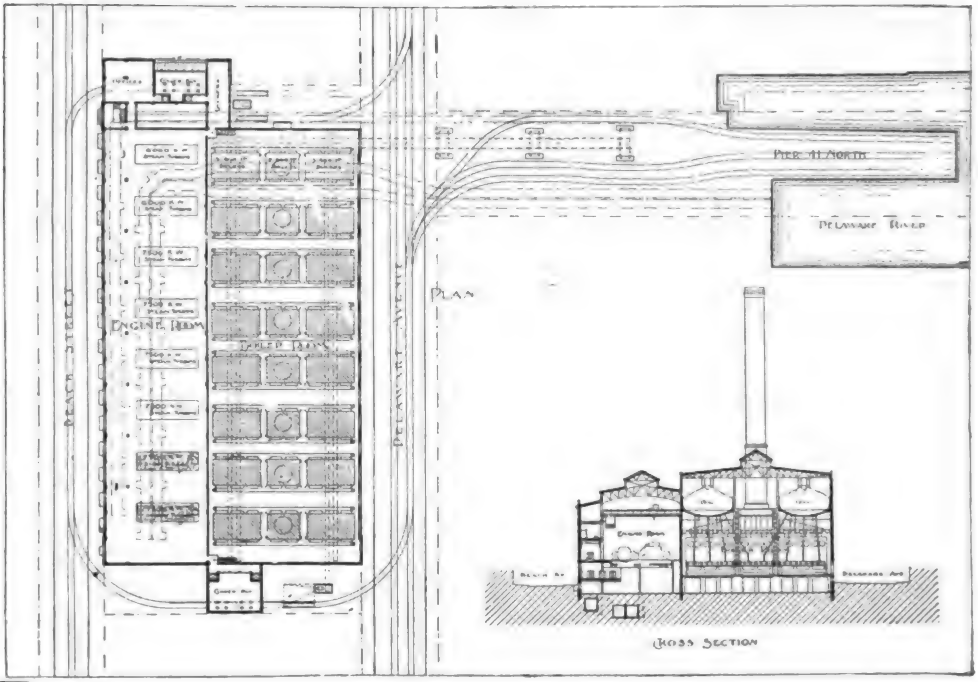


FIG. 2. DELAWARE AVENUE STATION—PLAN AND ELEVATION.

of two each of 700h.p., a special feature being a double ended grate, and the provision of a reverse circulation of the water to that of the combustion gases. Of the floorspace occupied by the reciprocating units which were at first installed, the two horizontal 2,000kw. sets (1,000kw. each) occupy more space than five turbo-units delivering 7,500kw. The difference is more marked because the turbines surmount their own condensing plant. The present plans for this station include a 65,000 ton coal storage, served by a double trestle and trolley cars. Reinforced concrete has been largely used in the construction of coal and cinder bins, and also for the cooling water reservoir.

The Delaware Avenue plant already mentioned, is, as stated, on a more ambitious scale, and its design embodies a number of new features. The boilers, for example, are placed parallel to the engine room in rows of eight, three at each end and two in the centre. Not the least extraordinary part of this arrangement is the mounting of a stack directly over the centre of each battery and supporting it on structural steel work from the ground level. This arrangement can be readily seen by reference to Fig. 2, which shows both plan and sectional elevation of the station. The steel supports rise to a point 50ft. above the boiler room floor, and from them the stack itself is raised to a point 175ft. higher. It was decided, for reasons of cheapness and lightness, to adopt reinforced concrete for the stacks, and each will weigh about 500 tons. Double plate girders resting on the steel structure form the base, and between these are placed anchor rods. The engine room will ultimately accommodate eight 6,000kw. turbo-units spaced at 40ft. centre with the exciter sets between. The condenser plant will occupy the basement 20ft. below floor level. The nature of the ground compelled the use of piles, and after a consideration of the use of wood, it was decided to employ concrete piles at 30 inch centres, each supporting a load of 30 tons. The superstructure rises from a skeleton steel construction, each column having an independent group of piles. The roofs are of cinder concrete slabs reinforced with steel, supported on steel trusses, and the tops are finished with tar and gravel roofing. The following figures are interesting; boiler room 51,200h.p., 39,440 sq. ft., or .77 sq. ft. per h.p.; engine room 55,500kw., 28,080 sq. ft. or .5 sq. ft. per kw. We are indebted for the above figures to the *Engineering Record.*

Uses of Niagara Power.

THE extent to which the hydro-electric power of Niagara is employed is not fully realised without the aid of statistics, and the following particulars, from the *Electrical World*, afford striking examples of the power contracts entered into with the supply companies. Bulk supply on such a scale in this country would make the existing power companies El Dorados of wealth, and place them beyond the pale of scoff and scorn to which it has hitherto been their lot to be relegated. The chief facts here enumerated illustrate clearly that manufacturing concerns can place complete reliance in a central supply source, and have absolute confidence in the reliability of the service.

"Buffalo received 24,000 electric horse-power from Niagara Falls last December, for the operation of lamps, stationary motors and street cars. Of this total about 7000 h.p. was delivered to the International Railway, and the other 17,000 h.p. represented the entire load of the electric supply system in that city. During the twenty-hour hours of December 5, 1904, the total electric load in the terminal house of the Cataract Power and Conduit Company for the Niagara transmission lines at Buffalo varied between a minimum of 7000 h.p. at 2.30 a.m., and a maximum of 23,900 h.p. at 5.15 p.m., as shown in Fig 1. On this same day the minimum load at the terminal house between 8 and 11.45 a.m. was 17,000 h.p. Compared with the like load curve for December 18, 1903, that of December 5, above-named, shows nearly the same minimum, and an increase of about 600 h.p. in the maximum demand.

On June 6, 1905, the total load on the Niagara transmission line at Buffalo had its minimum of 6000 h.p. at 4.45 a.m., and its maximum of 18,900 h.p. at 5 p.m. (See

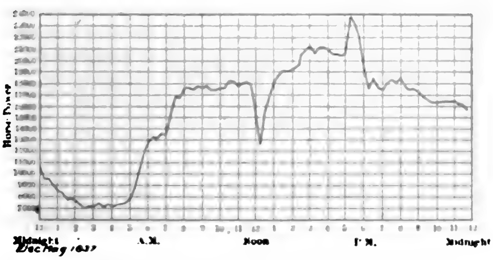


FIG. 1. NIAGARA LOAD CURVE (DECEMBER 5TH, 1904).

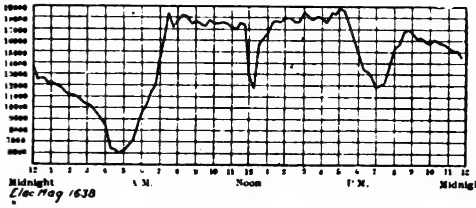


FIG. 2. LOAD CURVE ON JUNE 6TH, 1905.

F' 2.) About 6000 h.p. of this maximum was the street car load. Between 7.30 and 11.45 a.m., and between 1.15 and 5.15 p.m. the electric load was not below 17,000 h.p. This June load of 1905 was nearly the same at its minimum as the load on the eighteenth of the corresponding month of 1904, but the maximum load of the latter year was 1600 h.p. greater than that of the earlier. So also the lowest point of the day load between 7.30 and 11.45 a.m., and between 1.15 and 5.15 p.m., was some 3600 h.p. greater in 1905 than in 1904, on the June days named.

With an increase of load more than twice as great during the regular working hours of the day was at the time of peak load, it seems that the largest additions to the electric service in Buffalo are being made with motors for industrial purposes. An interesting illustration along this line may be noted in the 1500 h.p. direct-connected motor and vertical pump that has been installed at the pumping station of the Buffalo waterworks during the past year. This pump is of the centrifugal type, and has a capacity of 25,000,000 gallons of water per day of twenty-four hours, or 775,000,000 gallons per month of thirty-one such days. At the upper end of the pump shaft a vertical induction motor of 1500 h.p. capacity is connected, as indicated in Fig 3. Three-phase, 60-cycle, 2200-volt power is supplied to this motor by the Cataract Power and Conduit Company at the rate of nine dollars per million gallons of water pumped when 387.5 million gallons are pumped per month. On larger quantities of water per month the discounts from the pumping rate just named are as follows:—

387.5 to 465	million gallons......	11¼ per cent. discount.
465 to 542.5	,, ,, ...	20⅔ ,, ,,
542.5 to 620	,, ,, ...	29⅜ ,, ,,
620 to 697.5	,, ,, ...	37½ ,, ,,
697.5 to 775	,, ,, ...	44⅘ ,, ,,
775 and over	,, ,, ...	50 ,, ,,

This pumping is done against a water head of substantially 200 ft. The operation

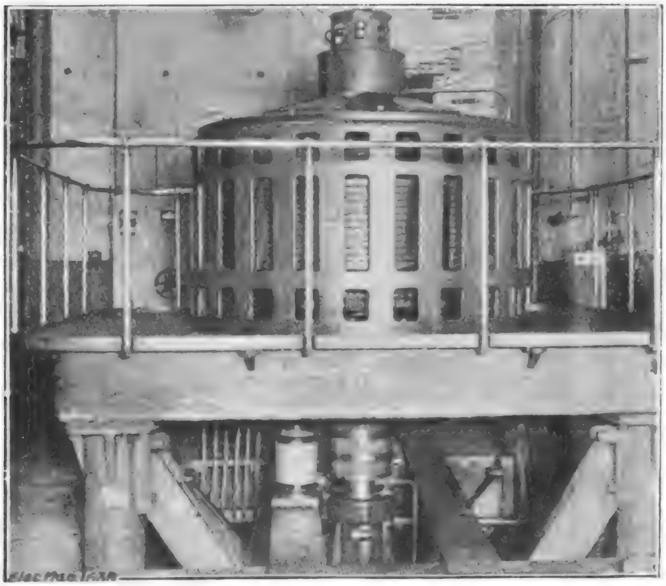


FIG. 3. 1,500 H.P. INDUCTION MOTOR, ON SUPPORTS FOR OPERATING CENTRIFUGAL PUMP.

of this pump is so economical in comparison with the cost of steam pumping, that the city of Buffalo is making plans for an electric pumping station to contain not less than eight 25,000,000 gallon pumps.

Transformers with an aggregate capacity of 18,096 16-c.p. lamps are operated with 25-cycle current from Niagara Falls for incandescent lighting by the Buffalo General Electric Company.

Such an extended application of alternating current at this low frequency to incandescent lighting is notable because of the opinion held by many engineers that 25-cycle current cannot give satisfactory results of this service. In spite of this opinion elsewhere, the load of incandescent lamps on 25-cycle circuits is rapidly moving upward at Buffalo, and lamps are being operated with such current in buildings where it is fair to assume that first-class service is demanded. The number of each size of service transformer operating incandescent lamps with 25-cycle current, and the total lamp capacity in each size, is given herewith. For these 255 transformers the average capacity is 71 lamps each.

Lamp Capacity, Each.	No. of Transformers.	Total Lamps.
12	43	516
20	41	820
30	51	1,530
50	38	1,900
80	27	2,160
60	2	120
70	2	140
100	19	1,900
150	3	450
180	2	360
200	6	1,200
300	11	3,300
800	1	800
490	1	490
90	1	90
160	2	320
400	5	2,000
Totals......	255	18,096

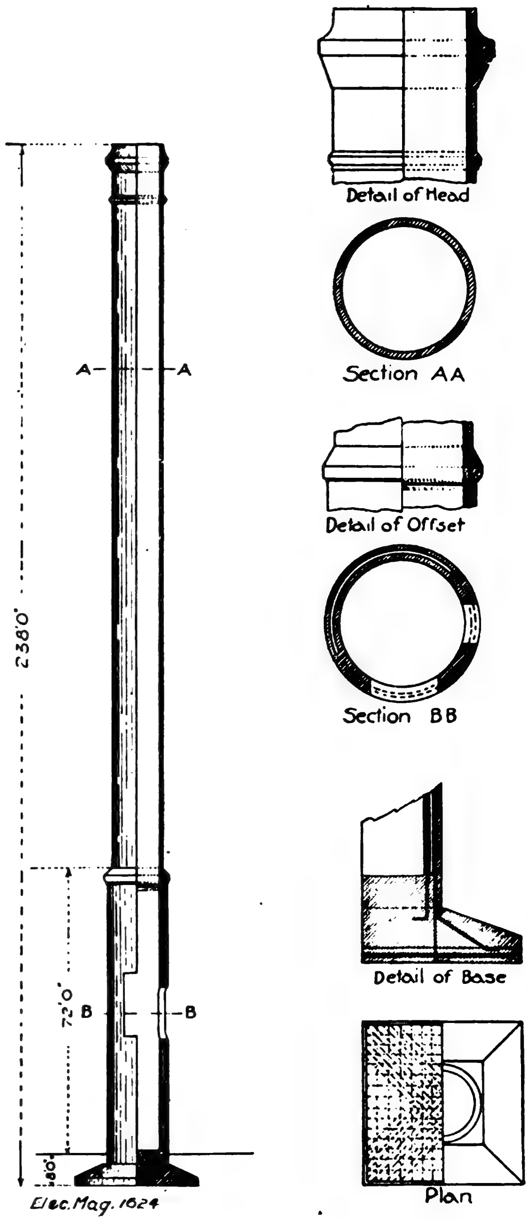
During the second half of 1904, the output of the Cataract Power and Conduit Company in Kilowatt-hours was greater by 15 per cent. than the output during the corresponding half of 1903. So, again, in the first six months of 1905 the company had an energy output greater by 18 per cent. than the output of the corresponding period of 1904. For the year ending with June 30, 1905, the number of kilowatt-hours delivered by the company showed an increase of 17 per cent. over the corresponding year ending in 1904, and 29 per cent. over the year ending in 1903.

Reinforced Concrete Chimneys.

BRICK chimneys were at one time regarded as the only possible form of structure for the creation of natural draft under steam boilers. They are now, however, rapidly giving way to steel and concrete, more particularly as construction costs for large power plants must be kept within such narrow limits. We illustrate a design of concrete chimney becoming common for this purpose, and also give data regarding its construction. These we have taken from an article on the subject contributed to the *Journal of Electricity, Power, and Gas*, by Mr. G. C. Mason. We also append several instructive extracts from the article, as this class of chimney construction has not yet become familiar in this country.

"During the past year the author has had the opportunity to erect two chimneys which dwarf into comparative insignificance the biggest chimney of one year ago. One chimney erected for the Portland General Electric Company has an inside diameter of twelve feet and rises 230 feet above grade. Another built for the Tacoma Smelting Company, in Tacoma, Wash., has an inside diameter of eighteen feet and stands 300 feet above grade. The latter is to-day the largest chimney built of reinforced concrete, but even now this is beginning to shrivel up in comparison with one in course of erection at Butte, Mont., which is to be 450 feet high. There are three kinds which naturally suggest themselves—brick, steel, and concrete. Where brick is cheap and ground space not too valuable this form of stack offers several advantages. Any shape or form of chimney is easily constructed, and the brick offers the necessary resistance to moderate heat. It offers considerable friction by reason of the many joints between the brick, and where intense heat is to be carried the brick chimney must be lined with fire-brick and fire-clay. The steel chimney is the cheapest to construct under reasonable conditions, but is the most expensive to maintain and has the shortest life of the three. The steel chimney, if made self-supporting, again becomes expensive, and the guys for one of shell construction are certainly not ornamental and may be a source of danger. If kept clean, the steel chimney offers little friction to the air, but it is too good a conductor of heat to make an ideal construction.

"The third form seems to meet the requirements to a far greater extent. Monolithic concrete is smooth on the surface, a non-conductor of heat, requires no lining to resist any temperature, at least up to 1500 deg. F., requires no expense for maintenance, and because of its inherent properties becomes stronger and better with age. As to first cost, the three usually rank—steel, concrete, and brick. As to final cost, they almost invariably shift this order to concrete, brick, and steel. The difference even in first cost between concrete and steel is rarely so great as to warrant the use of steel for this reason for any but temporary purposes. The ground space, which is often very important, is economised to the greatest extent by the use of reinforced concrete—the saving over brick being about one-third. Until the development of a suitable system of reinforcing concrete it is impossible to use it in tall chimney construction, the tensile strength of concrete being insufficient to economically resist the wind stresses. At this time it is not necessary to more than enumerate the principles



Sectional Views of Typical Reinforced Concrete Chimney.

upon which reinforced concrete depend. The steel is embedded in the concrete to take care of the tensile stresses, the concrete itself resisting those due to compression. Steel properly embedded in concrete does not rust or otherwise deteriorate. Steel and concrete in proper combination act not as two materials, but, by reason of their adhesion, practically become one and act together. The coefficient of expansion, which of course is a matter of considerable moment in a chimney subjected to great heat, is for all practical purposes the same in both steel and concrete. Much has been written about the adhesion of concrete to steel, very much of which is for business purposes rather than engineering. This much seems to have been proven—that the adhesion varies directly with the exposed surface area of the steel, and as the strength in tension depends upon the sectional area, the end desired is to get the greatest surface area exposed for adhesion with the requisite cross-section for tension. Inasmuch as T-steel gives a superficial area of almost twice that of round or square bars, the T-shape was used in both these chimneys.

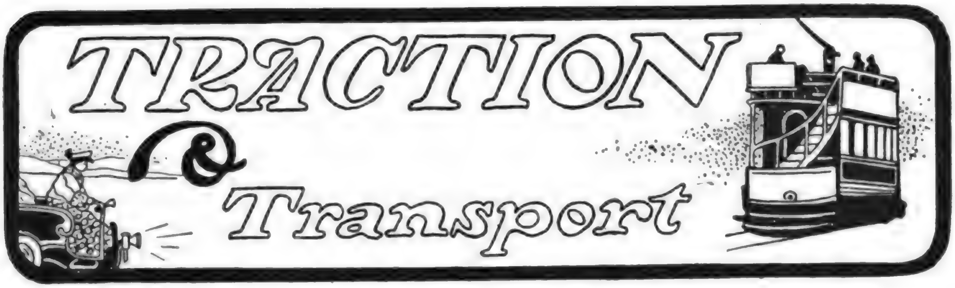
Power Consumption for Various Trades.

PARTICULARS of the average use of electromotors in different trades and industries are of immense value in assisting the accurate determination of power rates in certain specific cases. Data of this kind are only collated after elaborate and diversified tests extending over many months and with many classes of machinery. We have prepared the adjoining table from particulars contained in a recent contribution to the *Western Electrician*. A number of small and large trades are classified and figures given of the average number of hours in which the motors were used.

Trade.	No. of Works.	Average Hours Motors used.
Smelting Works	15	0.48 per h.p.
Wood Working	20	0.36 "
Meat Chopping	20	0.9 "
Hat Making	12	1.49 "
Marble	—	1.63 "
Machine Shop	—	2.1 "
Shirt Making	—	7.14 "
Corset Making	—	3.77 "
Instrument Making	—	3.00 "
Jewellery Making..	—	2.93 "
Printing (Indu. Motors) ..	—	2.48 "
Miscellaneous Collection of above	50	2.25 "

This low average clearly indicates that a much greater number of motors can be installed for a given output of the generating plant, and at least it proves that the figures commonly employed for estimating purposes have been based on much too high a standard. Where engineers have the opportunity they should endeavour to ascertain the hours of use to which motors are put on their mains.

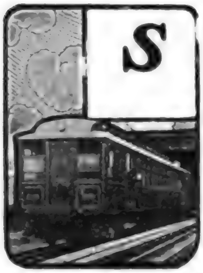
The average power consumption of motors on supply mains is also a matter for consideration. When a prospective client is being approached to throw out a gas or steam engine it is constantly instilled into him that when his motor is not required it consumes no energy if promptly switched off. Where individual motors are subsequently installed economy bordering on parsimony will become the motto of the power user and the average energy consumption will be much below that estimated by the engineer when obtaining the order. From the same source mentioned above we obtain some details of the operation of machine shops in which wattmeter readings had been taken of the energy consumed by the motors. With motors running light and shafting together consuming 2.112kw., the average hourly consumption did not exceed 3.6kw. with ordinary load on. These figures were the average of investigations covering some half-a-dozen machine shops. Even more interesting are some comparative costs of operating a modern octuple web printing press with different grades of paper. The poorer grades reduce materially the speed at which the run can be made, and the current consumption is accordingly heavier with cheaper papers. At slow speed 35,000 12 page papers could be printed in an hour for an expenditure of 40kw. or 1.112kw. per thousand. With the higher speed only 920 watts per thousand was needed, and in the same time 40,000 copies were printed. As a general rule with presses of this character it may be taken that slow speed working will entail an extra 20 per cent. in the current consumption and the edition will also be reduced.



A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

A One-Phase Railway Situation.

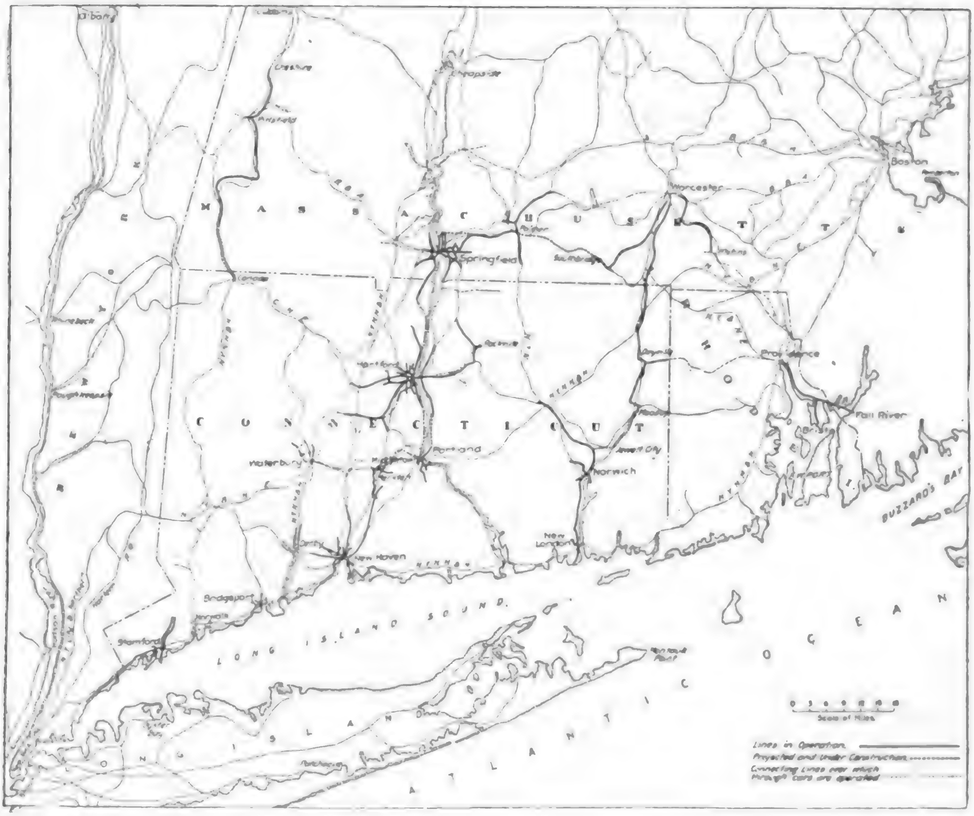
By MERCURIUS.



SOMETHING like a bombshell has just recently been hurled into the camp of the direct-current-multiple-unit-third-rail section of electrical railroaders in New York. No need to remind readers that Manhattan Island and its immediate environs is just reeking with direct-current third rail systems, and nothing in the nature of alternating currents has been allowed in the vicinity, doubtless on principle. Now comes the news that the New York, New Haven, and Hartford Railway Company has ordered a number of one-phase locomotives from the Westinghouse Company, and will run them over the tracks of the New York Central, which are now being equipped for operating direct current locomotives and multiple unit trains. The situation is highly interesting, as, in the first place, it indicates what may happen when surface lines stretching into the country are equipped wholesale with the third rail system and, secondly, it illustrates, and to our thinking in no uncertain manner, that American electrical engineers are determined to push one-phase traction for all it is worth and with the minimum of delay. As far as can be gathered, the first announcement was made by Mr. C. F. Scott in his paper on one-phase railways (abstracted in our last issue) before the American Street Railway Association. The immediate effect of this was a strong rejoinder from the pen of Mr. J. F. Sprague in the columns of the *Street Railway Journal* denouncing the policy of the particular line and frantically eulogising the merits of multiple-unit third-rail methods. This letter elicited others from eminent railway men, and a right merry bout followed in which the direct current section decidedly got the worst of it.

The New York Central, it appears, is spending some 60 million dollars in converting its suburban tracks from steam to electric driving, and under the advice of a Traffic Commission appointed for the purpose has adopted the direct current third rail system, fed from eight rotary converter sub-stations supplied by two polyphase power houses. Huge locomotives will draw the long-distance trains, and motor-car trains controlled by the multiple unit system will handle the local service. A full description of these locomotives has been published in previous issues, together with data comparing their performance with the steam locos doing similar duty. At the Grand Central Station, New York City, elaborate provision has been made for handling the traffic. The locomotives will enter the station at an upper tier, which will always serve for the high speed long distance traffic. A lower tier will be employed for the multiple unit trains, which will also be handled over a special loop with suitable cross-overs, &c., for rearranging the trains.

The New York, Hartford, and New Haven Railway Company has for the past fourteen years done pioneer work in the construction of inter-urban and urban electric roads, and at the present moment either owns or controls twenty-two lines representing some 600 miles of track. The adjoining map indicates the "territory" over which it operates, and also



By permission] [*"Railway Gazette."*

Map showing Electric System of the New York, Hartford, and New Haven Railway Company.
The proposed One-phase Locomotives will run initially between New York and Stamford, shown in left bottom corner of Map.

shows its contiguity to New York City. The entrance into that place is at present only possible over the New York Central lines, which are first touched at Woodlawn, some 12 miles from the Grand Central terminus. For the privilege of using this terminal the company are paying the New York Central £7000 a month, but it has plans in view of separate tracks into its present terminal in 135th Street, which is likely to provide equal facilities to those afforded by the Grand Central. In view of its extensive trolley roads beyond the borders of the city, and of its facilities for entering therein, the New Haven Company, although represented on the New York Central Traffic Board, refrained from being drawn into the third rail direct current policy of that company, and withheld any decision until recently regarding the electrification of its tracks into New York. That decision, as we have already said, favoured the introduction of one-phase locomotives which would also operate, presumably temporarily, over the direct current stretches of the New York Central lines.

It is this part of the business which Mr. Sprague inveighs against, and his maledictions cover some four pages of our American contemporary referred to. Here are some of his choicest statements :—

"I regret that so seemingly bold a step has been taken when a.c. operation must necessarily be handicapped by various physical, engineering, and operative conditions over which neither the New Haven road nor the contracting company can have any control, which the nature of things makes it impossible to change, and which will surely interfere with the full fruition of the hopes of those who have committed themselves to this proposition." "The a.c. motors proposed are designed to work at a

maximum of about 250 volts at full speed, and when in the d.c. zone they must be coupled in series in pairs because of the higher potential. . . . Locomotives will require an increase of over 100 per cent. of current up to about 12 m.p.h., which constitutes a considerable part of the yard movement."

In the matter of current supply Mr. Sprague foresees many complications. He says:—" Either there must be a single supply from the power houses of the Central for both a.c. and d.c. operation, or d.c. supply for 12.5 miles by the Central's power house, and single phase a.c. supply for 19.5 miles from an independent station. Joint supply in the d.c. division is simply out of the question."

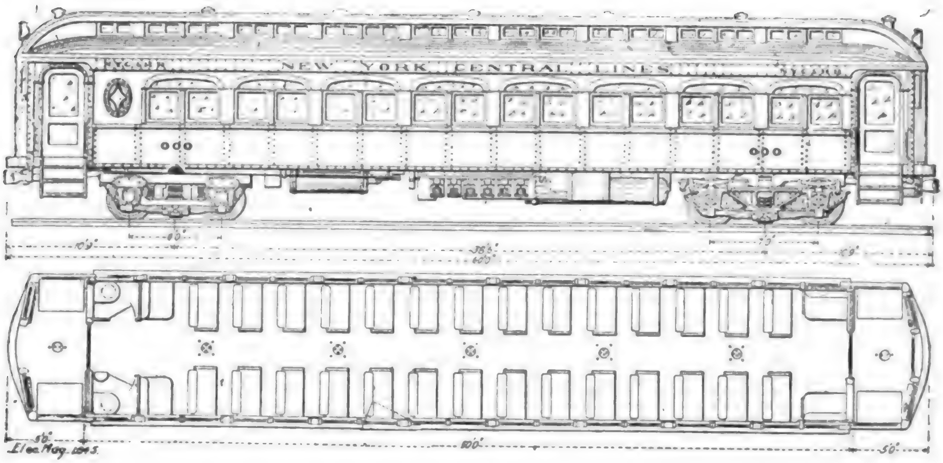
Foreseeing the possibility of independent stations, it is assumed that " the proper determination of the relative amounts of energy used by the equipments of the two companies under the complicated conditions of train operation with supply from two main power stations and the necessary duplicate sub-stations feeding a common working conductor, would be more difficult."

Mr. Sprague then cites the difficulty of supplying one-phase current to a separate working conductor from the polyphase stations of the New York Central through static transformers, and considers polyphase —one-phase motor generators—a decidedly bad alternative. Throughout the whole of his argument Mr. Sprague strongly deprecated anything in the nature of experimenting by railroad concerns, assuming that direct current electric lines with multiple unit trains were beyond the pale either of development or supersession. He ignored the monster locomotives of the Central doubtless for the same reason. He concluded by stating that "every engineer stands ready to welcome accomplished facts and help in the progress of the art, but for the best interest of that progress it is vital to avoid not only unwarranted claims, but adverse statements which will not bear critical analysis."

Of the comments called forth by Mr. Sprague's letter several are worth quoting from. Mr. Calvert Townley, engineer to the New Haven Road, in the course of his reply says: "That the progress of the art of locomotive design since the purchase of the locomotives adopted by the Central some two years ago has enabled the New Haven road to procure a type which, in addition to operating on the Central's continuous current

VIEW OF WESTINGHOUSE ONE-PHASE LOCOMOTIVE, AS CONSTRUCTED FOR HEAVY FREIGHT SERVICE.

Somewhat similar type will be supplied to the New York, Hartford, and New Haven Railway Company for its suburban tracks outside New York. The locomotives will operate on both Direct Current over the New York Central Lines and H.T. Alternating Current on the company's own sections.



Type of All Steel Motor Car with Multiple Unit Control, as will be used on the New York Central Electrified Suburban Lines.

The locomotives for the long distance traffic have been referred to in previous issues.

system, is also capable of operating on a single-phase alternating current, thus widening the possible application of electric traction for future extensions on the New Haven's electrical system, should be a source of gratification rather than of censure or alarm. Mr. Sprague's unfamiliarity with the up-to-date development of electric locomotives has, perhaps, led him into his dire prognostications of disaster, and while, under the circumstances, an extended argument can be of little avail I have no doubt that the management of the New Haven road will be quite content to await the practical results which will very soon furnish substantial evidence of the correctness or error of their judgment." This letter is immediately followed by one from Dr. Louis Bell, who has had extensive experience of railway and power transmission matters in the States. In introducing the subject he says: "In reading his (Mr. Sprague's) discussion of the situation I am impressed by the possibility that he has not entirely taken into account the larger and more remote features of the matter. Personally, I have long believed that, however successful the d.c. third rail system may be in dealing with purely suburban and terminal work, it has limitations in the matter of the electrical distributions that are forbidding when one comes to consider the larger railway field. As a practical matter, I consider high voltage on the working conductor a virtual necessity in dealing with the electric railway of the future, and this of itself implies the laying aside the third rail system for conductors placed where they can be adequately insulated." Again he seems to beg Mr. Sprague to calm his troubled spirits, for "it is up to the contracting company to make good its guarantees and to make a success of these locomotives if possible. No wise railwayman is going to assume the responsibility for that part of the work, nor is he likely to be asked to do so. It is pretty evident that the contractors believe they can make good, and I am glad that someone has had the courage to undertake, the very important work of developing to its legitimate conclusion single-phase traction on a large scale."

We have not yet seen any rejoinder from the contractors, but doubtless they are content to let this storm break over their heads, confident that they are well established in their convictions and unlikely to be moved by any hostile demonstrations from the opposition camp.

Generation or Purchase?

A Question for Railway Companies.

The adoption of electric traction on the chief lines in and around the Metropolis raises hopes of electrification on a smaller scale of the chief railway feeders into large towns and cities. When questions of this kind come up for settlement the matter of purchasing or generating the necessary energy will also need consideration. The following notes taken from the *Railway Gazette* go generally into the subject and will

be found worthy of careful study. They should give pause to any company which may be thinking of passing over the question as of little or no importance.

"The generation of electricity began like other things on a small scale, and its supply was limited at first to single buildings. But the area and the variety of demands supplied from one centre have steadily increased, until first towns and now whole counties are economically fed from one power station. This increase has produced a corresponding increase in the size of generating stations, and consequently a saving in the cost of construction and working. But perhaps the most important economy which results from an increased area of supply is the greater variety of the consumers in it, for the greater the diversity of the demand the better the 'load factor' of the system; in other words, the longer the period each day during which the plant, and hence the capital sunk in it, can be employed.

"The objection which has been frequently raised to the concentration of power supply in one large centre has been the danger of breakdown, the economy in capital and working expenses being generally conceded. And while stations were in the early stage of development from, say, 1,000 to 5,000 h.p., there was good reason for this fear. As electrical machinery, however, became more reliable, and the size of stations increased, this objection was removed; for the modern power-house consists not of one, but rather of a series of independent power-houses. What is known as the 'complete unit' system is now adopted. The station plant is divided into a number of complete sections or units, each of which may be operated independently, being provided with its own coal bunkers, economisers, chimney, feed pumps and all auxiliary apparatus, practically the only junctions between the various sections being :—

"(a) The railway siding from which coal is taken to the various bunkers;

"(b) The source of circulating water supply;

"(c) The main electrical bus bars.

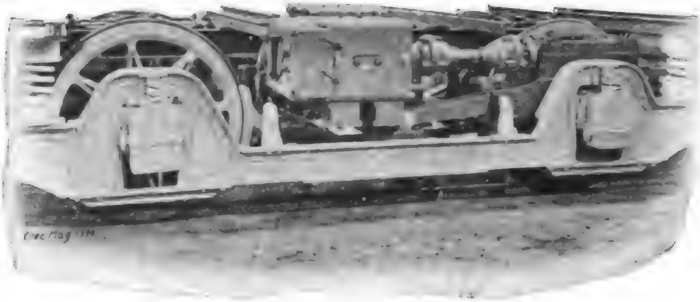
"Security of supply, the first essential of a satisfactory design, is better ensured by this arrangement, for a breakdown, whether serious or not, on any individual piece of apparatus cannot affect more than the particular 'unit' with which the apparatus is connected. Extensions of the station are much simplified, as it is a question merely of duplicating the existing plant and buildings, or of adopting any modification of generating machinery, either in size or type, rendered desirable by engineering progress, without interfering with existing arrangements or the symmetry of the original design. By this means a complete breakdown is entirely avoided; every single piece of apparatus from the coal sidings to the chimney being in duplicate or triplicate, as the case may be.

"The larger the scale upon which a station is built and electricity produced, the lower the capital and working charges. It was recently given in evidence before the House of Lords that a station with a total output of 30,000h.p. such as would be required for running an average suburban line, would cost probably at least one-half of a station of 100,000h.p., while the expenses of production per unit would probably be 15 or 20 per cent. more. It is often said that a limit is reached in the economy of large stations, and that beyond a certain size the gain resulting from a further increase is negligible. As regards working expenses this is to some extent true; but as regards the capital cost, there is always a gain in increasing size, and this is especially the case since the introduction of steam turbines. Every year sees an increase in size, and a consequent reduction in the cost of these machines and the power-houses using them.

"Each case must be decided on its merits, but from the point of view of economy alone it would, generally speaking, appear that the supply of power by a company specially organised for this purpose on a scale very much larger than that of an independent station is the more economical method of dealing with the question. And, as we have already shown, there is no reason why it should not be the more reliable method. For whereas it would seldom pay the railway company to put down more than one power station, each great station of the power company will consist of three or four stations, affording a far stronger guarantee against complete failure than the addition of further spare apparatus in the station itself. It may be urged that the railway company's station could also be built upon the complete unit system, but to do this would, as a rule, involve the use of a smaller size of unit than economy alone would suggest.

"No general rule can be laid down. For when the requirements of the railway or railways are great enough, as in the case of the

London Underground Railways, to necessitate a station of at least 100,000h.p., there is little gain in increasing the size by supplying other needs therefrom. But such a case is exceptional; generally speaking a much smaller station will suffice. And the railway companies have always plenty of out-lets for their capital in other directions than the erection of power stations."



WORM-GEARED MOTOR AND TRUCK, SHOWING NEAR VIEW OF FLEXIBLE COUPLING AND MOTOR MOUNTING.

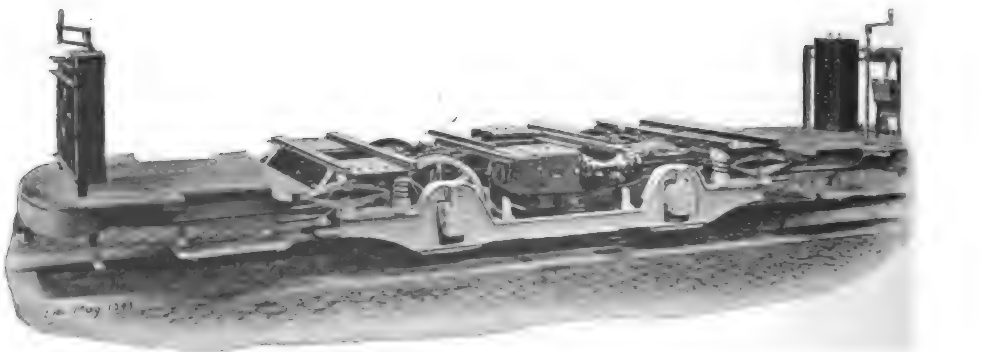
Worm Gearing for Traction Purposes.

UNTIL quite recently electric traction engineers have been wedded to spur gearing for the transmission of the motor power to the axles of either tramcar or train. When the motor axle is thus placed parallel to that of the object driven, certain limitations of space are imposed, and the motor must on no account exceed these dimensions. Gear-wheel and pinion have hitherto been regarded and employed as the only satisfactory solution of the problem of speed reduction from motor shaft to wheel axle. An experimental tramcar fitted with worm gearing was built some months ago by the Oerlikon Co., of Zurich, for the Zurich Oerlikon Seebach System, and has since been in constant service with a view to testing its capabilities beside motors of the ordinary geared pattern. From the point of accessibility the worm geared motor is far superior to the machine placed in the body of the truck between the wheels. A glance at the illustrations herewith of a car fitted with worm-geared motor will at once bear out this point, while it is obvious that the motor can be more generously proportioned and will be less liable to heating troubles. The removal of the coupling nuts and holding-down bolts makes it possible to dismount the motor bodily from the truck, and if need be, substitute it for another in a short space of time. It will be seen from the view of the car-truck that the gear-wheel is fixed to an extension of the axle and that both worm and wheel are completely enclosed in a stout housing. The car attached to the truck has a carrying capacity of thirty-eight persons at a speed of 9½m.p.h., corresponding to 1,200r.p.m. of the motors; 20h.p. per motor is delivered to the wheels. The gearing has the following dimensions:—

Worm.—Number of threads, 3; pitch of thread, 4.8in.; diameter of pitch circle, 2.75in.; direction of thread, right-hand.

Worm-Wheel.—Number of teeth, 36; pitch, 1.6in.; diameter of pitch circle, 19.25in.; ratio of gear, 1:12.

The worm is of hardened and ground steel and the worm-wheel is strengthened with a



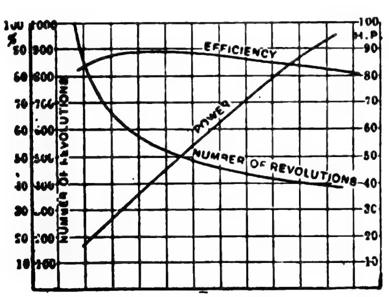
COMPLETE VIEW OF WORMED-GEARED MOTORS AND TRUCK.

phosphor-bronze rim as an extra safeguard. The bearings of the gear are cast into the enclosed steel housing, and the worm-axle is lubricated with rings constantly dipping into the oil. The end thrust is taken up by a special ball bearing, and between the motor-shaft and the worm a flexible shaft is employed. This is essential to allow of the vertical movement of the driving axle as it follows the inequalities of the road.

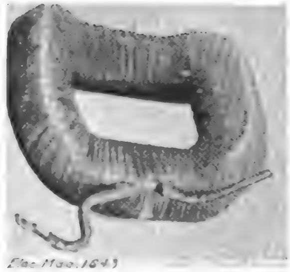
A drive of this description also contributes largely to the comfort of passengers at starting. The jars and shocks due to spur gearing when getting under weigh are notorious, and in some instances have caused falls from the stairs and steps, and nasty accidents. With the worm-wheel this is entirely obviated, and smooth starting can always be depended upon.

High Voltage D.C. Traction.

OUR Continental electrical confrères have always been partial to high voltage work with direct currents, and from time to time we have recorded the results of their efforts in this direction. It is not surprising to hear, after the success achieved with this class of apparatus, that experiments are pending with railway equipment for operation directly from high voltage lines. Our German contemporary *Elektrische Bahnen* recently gave very minute details of a system shortly to be installed on a road between Bellinzona and Mesocco in Southern Switzerland. It is proposed to employ a trolley voltage of 1500 to 1600, and four motors will comprise the hauling element. A maximum load of 60 tons will, it is estimated, be hauled up a 6 per cent. gradient at 20km. per hour. The construction work is in the hands of J. J. Rieter & Co., who have built series



EFFICIENCY CURVES OF H.V. D.C. TRACTION MOTOR WHEN OPERATED AT 1,500 VOLTS.



VIEW OF SPECIAL FIELD COIL FOR HIGH VOLTAGE D.C. TRACTION MOTOR

motors for lower voltages for some time. Close details of the motor construction were given in the article. To admit of adequate insulation in the armature winding, five segments per slot were adopted, but to obviate commutating difficulties and avoid special poles a large neutral zone was provided, the ratio of pole arc to pole pitch being .067. A stable external field is obtained by a high flux density in the armature teeth and by specially constructed field coils. The field coils are turned up on either side to approach the armature circumference in the neutral zone and thereby obtain some compensation of the armature field.

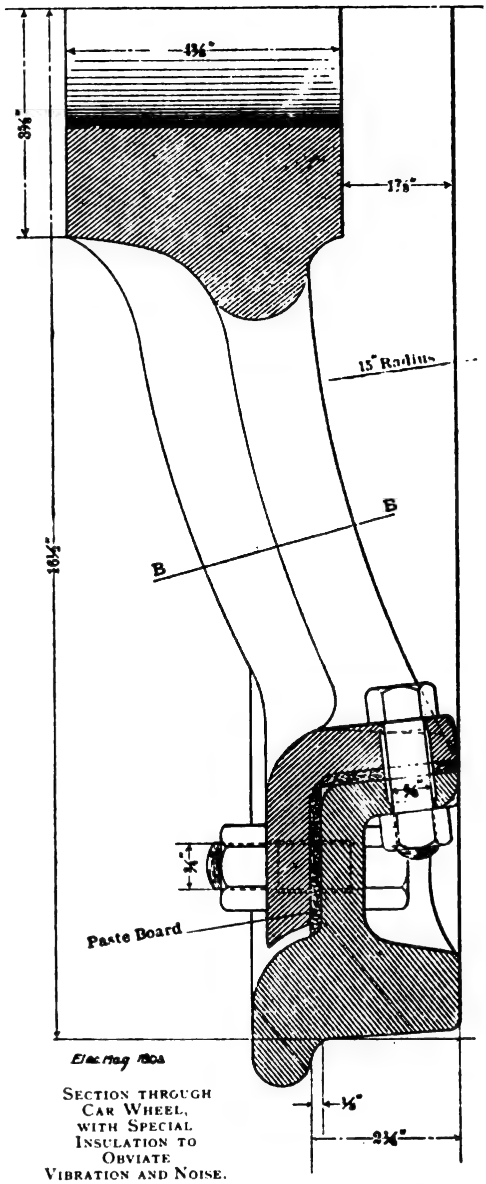
The gauge of the line is 3ft. 3⅜in., and the power at the motor axle for one hour's continuous operation has been fixed at 75h.p. The chief dimensions of the motor are: Armature diameter, 17.3in.; armature breadth, 8.7in., including a ventilating duct of 0.4in.; number of slots, 53; number of segments, 265; commutator diameter, 14.2in.; useful width of commutator, 3.5in.; motor resistance at 70° C., 2.65 ohms. The insulation has been carefully gone into, and it is stated that a testing voltage of 6000-7000 between winding and frame has been successfully applied. At full load, although 28 per cent. of the armature current was shunted away from the field coils, sparkless running was obtained, and even when the shunt circuit was switched out sparking was entirely absent. At an output of 90h.p. on a 1700-volt circuit the motor behaved well, and it is believed that a voltage of 1800 to 2000 could be applied without injury to the machine. On a full load test of 75h.p. for one hour the temperature rise above atmosphere was 72.5° C. in the armature iron, 62.5° C. in the field coils, and 44.5° C. in the commutator. The makers are very confident that the motor will meet all the requirements of actual service with ample margin of safety and with the highest efficiency.

A Noiseless Car Wheel.

To avoid the necessity of taking a car wheel off the axle after the flange and tread have worn out, C. W. Haight, of Dayton, Ohio, has brought out the Hoagland noiseless car wheel. The flange on the centre part is on the inside, projecting outward. The tyre flange is on the outside, projecting inward. Between these two flanges is a space of about $1\frac{3}{4}$in., and in this space is the bearing surface. Between the two castings there is sufficient room for a $\frac{3}{16}$in. paper packing. No parts of the two castings come in connection with one another; no bolt holes are drilled; and the only machine work which is necessary is the grinding of the inside of the flanges and the bearing face, only to grind off rough spots and lumps, thereby avoiding lathe and drill press work. It is not necessary to grind to a polished surface.

The taper on the bearing face forms a wedge, which presses the paper packing between the two castings, and the pressure is secured by twelve or fourteen $\frac{3}{4}$in. bolts and a wrench 20in. long. In putting one of these wheels together, the centre and tyre can go together about one-third of the bearing face before it comes to a solid bearing, and two-thirds is thus pulled up with bolts, furnishing, with a suitable wrench, from twelve tons to fifteen tons pressure, and thus avoiding a hydraulic press. The bolts and nuts used in the construction of these wheels are secured by nut locks. One nut lock is placed between the bolt head and casting, and another between the nut and casting. The bolts, nuts, and the nut lock under the bolt head, can be used again and again, but the nut lock under the nut will split in two or more pieces in taking off the nut.

Among the advantages claimed for this wheel are the following :—The paper packing between the two castings acts as a cushion; no ringing sound in the wheels; great reduction of noise when running; prolongs the life of the road bed and truck apparatus; cheapness of the wheel after once placed in service, as it will cost little over one-half of an ordinary car wheel to renew the tyre, which is the only part of the wheel that wears out; the wheel has a deep uniform chill all round, and no soft spots can form in its tread, as the tyre is of uniform thickness with no spoke in it; no possible chance for this wheel to break in running over railroad crossings, frogs, or by frost in cold



Section through Car Wheel, with Special Insulation to Obviate Vibration and Noise.

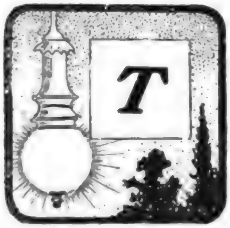
weather, as the cushion in them prevents cracking; the tyre on solid wheels is only supported at each spoke, but in this wheel it is equalised—a fact of great value. It is interesting to note that this car wheel has been used for four years on the Chicago and Milwaukee Railway, and that several of this company's officials have expressed themselves as being highly pleased with the results that it has given in practice.—Street Railway Journal.

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

Light and Leading.

A Plea for the Illuminating Engineer.

By SMILAX



THE electric light is a good light and a cheap, but it wants leading —badly. The vast army of technical and non-technical advisers on electric lighting matters is at the moment without general and staff. It has got something to fight in the gas interests too, but that circumstance only serves to emphasise its present lack of "efficiency." In a word the art of illumination by electric lamps needs crystallising into something like definite shape, and good men are wanted at once to do it. There is no lack of materials, munitions of war as it were, but the experience in assembling and marshalling these to best advantage has yet to be definitely embodied in a distinct class of experts, men whose yea or nay on matters illuminating shall be final.

The problem is a perfectly simple one, and the factors determining its solution are few. When light is required in a building it should obviously be put to the best use, that is, effective distribution should be ensured with a proportionate consumption of energy, and unless this is done the contractor, consultant, or whatever he styles himself, has not satisfactorily completed his contract. Failures of this kind are unfortunately too frequent and can be traced to the unprofessional conduct of architects and others who trade on the lack of knowledge in these matters of their clients. A man concerned with building quantities and architectural design surely has his attention fully occupied without running in the direction of illumination.

The chief offences against our known laws of artificial illumination are committed in large mansions, public halls, theatres, and churches. The proprietors or owners leave everything in the hands of one general adviser who has his fingers in every contractor's pocket and cares little for the effect of the completed work on those resorting to these places.

"I think a light here would be nice," or "We *must* have a light just there" constitute the instructions of the man who pays, and this inane wish spoken from the surface of a mind otherwise occupied is faithfully recognised.

For any installation of and above fifty lights the services of an expert "illuminationist" are required, and we must follow the example of our American cousins and get him made "right now." There is a field here. The money spent on advice will frequently be saved many times over in current economies and light distributed. Such a holy mess of things has been made by wiring contractors who have blindly followed architect, jobbing consultant, and any Tom, Dick, or Harry acting for the particular customer, that some drastic remedy must be applied. We have light makers and lamp sellers enough, but have small stock of men who can say from back of their experience, "That lamp is worthless there, and must go here." The cry now is for more light, and this we take up and repeat, but let us make ourselves heard above the clamour, that we must have both light *and* leading.

Window Lighting.

By E. R. ROBERTS

THE subject of window lighting, especially after shop hours, is a matter of great importance to electricity supply concerns. It should form the subject of a special campaign, and by offering reduced rates shopkeepers should be given every inducement to leave their window lights on after closing time. A two-rate meter and a time switch are the only additions needed to the service. The following remarks on the subject are taken from the *American Electrician* and will repay careful perusal:—

"To the central station manager who is anxious to improve his load factor, the lighting of store windows would seem to be a very attractive field. The central station manager has for some time appreciated the benefit which accrues to him as well as to the customer through the sale of electric current for advertising in the form of electric signs; yet the field of window lighting, which should prove fully as lucrative, lies in a state of more or less neglect.

"One cannot travel about the country, especially the smaller towns, without realising more and more that such is the case, and that the art of window illumination as practised by many so-called enterprising merchants falls far short of what good practice demands. Reviewing the situation, one comes to the conclusion that the cause of this state of affairs is a lack of co-operation between the merchant and the light man, with the result that the window installation is off duty during the period when both parties need it the most.

"During the rush of business hours people have no time to stop and view window displays. That pastime is reserved for the evening stroll after dinner, when business worries have been put aside for the day and people are actually on the lookout for something to claim their interest. Needless to say, a dismal, poorly-lighted business street at night repels about as many pleasure seekers and strollers in search of recreation as a brightly-lighted thoroughfare attracts.

"The advertising value of well-illuminated store windows during the evening hours after business has ceased, is not a theory, but a substantiated fact, which any up-to-date merchant will appreciate and be eager to take advantage of just as soon as the electric lighting company meets him half way with a reasonable proposition. The merchant has the incentive, but awaits the inducement. Meanwhile, he continues to throw off his window switch at closing time.

"The central station manager no doubt appreciates the value of the long-hour customer, and goes after every drug store, saloon, or restaurant in sight. The owner of show windows is no less desirable as a customer, and it is to the lighting company's advantage to make a rate for window lighting during the evening hours which will be well-nigh irresistible to a progressive merchant.

"Window lighting service is needed continuously during a definite period of each day. It is more or less isolated and free from interference, and is much the same as electric sign service. Consequently, the flat rate system of charging is especially applicable and has its strong advocates. In any case,

A TYPICAL ELECTRIC SIGN IN THE CHINESE QUARTER OF SAN FRANCISCO. THE CHINESE CHARACTERS REPRESENT "THE OLD COMPANY."
The Gas and Electric Company does quite a thriving business with gas and "juice" among the Chinese, despite the American boycott. The illustration is from the New York *Electrical Review*.

whether the meter or flat rate be employed, the problem of shutting off the light at midnight, or earlier if desired, is easily solved by the use of an automatic time switch, which may be sold or rented to the customer.

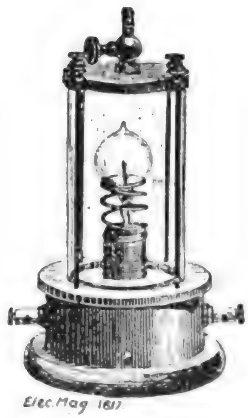
"In a window-lighting campaign the electric light company should not only establish an attractive charging rate, but it should lend its influence towards the more intelligent use of electric light as a means to an end, thereby bringing to the attention of its prospective customers the advantages of electric service, while at the same time winning the confidence and respect of its patrons.

"Another point which demands careful consideration in window illumination is the colour or quality of the light provided. It is a well-known fact that coloured goods and wares are only seen in their natural hues when viewed by natural light, and tnat the various tints are materially altered by the use of artificial light of different qualities, a notable example of this being the effect on colours produced by the mercury vapour lamp. Since the window space of a store is set apart solely for the purpose of attracting buyers it is evident that a light of suitable quality is of even greater importance here than it is in the store itself.

"The incandescent lamp by virtue of its neat, compact structure in comparison with the bulky arc lamp, and its numerous advantages over the Welsbach gas lamp, has grown very popular in the field of window lighting; yet, in the orange colour of the incandescent light there is still much to be desired. The efficient Nernst lamp with its softer and whiter light is particularly applicable in this field where alternating-current is available."

Dangers of Miners' Electric Lamps.

It is frequently argued that the ordinary incandescent lamp bulb can be placed in close proximity to inflammable substances with complete impunity. Instances are on record of shop-window fires caused by the draping of incandescent lamps with flimsy materials, a practice at one time quite common until its consequences gave rise to more caution in handling the lamps. It is not difficult to conceive that for the same reasons great care is required in placing down naked incandescent lights on heaps of coal dust or even on very small coal. Researches and experiments with incandescent lamp bulbs in close contact with carbon dust have produced some very striking results. Our French contemporary *L'Ecıairage Electrique* has recently published particulars of the effect of the heat from a 100 volt 16c.p. incandescent lamp on heaps of carbon dust. Within three minutes of the first contact smoke was evolved, and a period of twenty-five minutes was sufficient to start combustion. These results clearly point to distinct dangers in leaving open lamps even for a short time in close proximity to coal dust or small coal. The danger, moreover, is accentuated by the fact that spontaneous combustion may occur after the removal of the lamp, when all fears of further trouble may have been allayed. In mines the effects of so simple an incident are fraught with very disastrous consequences, so that too stricta supervision cannot be kept over the manner in which hand lamps are employed. While it may be and doubtless is the practice to use hand lamps with a wire guard or some form of protecting device, safety appliances of this kind do not go far enough; in guarding the glass bulb from injury they effect no control over the supply circuit, so that in the event of their removal the lamp may still be lighted. The adjoining illustration shows a patented lamp in which the filament is encompassed by two glass globes, an inner and an outer. Should the latter be broken the circuit is at once interrupted and all danger of fire is at once removed. The ordinary bulb enclosing the filament and its terminals is also arranged to break circuit in case of damage to the glass. This precautionary measure is adopted to obviate the risk of the filament



View of Tommasi Safety Miner's Electric Lamp. The outer globe, when in position, completes the circuit, and, if broken, at once interrupts it. The breaking of the inner globe from any cause also cuts off the current.

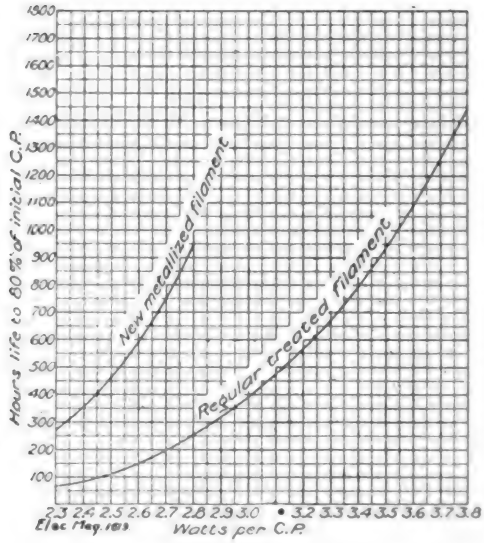
remaining incandescent a'ter the fracture of the glass, as any inflammable gas would be immediately ignited unless the current was at once interrupted. The switching devices are very simple in character and quite positive in their action.

The fire risks occasioned by the careless handling of incandescent lamps in coal mines also apply to confined spaces in which large quantities of fuel are stored. Thoughtless workmen may inadvertently be the cause of a conflagration, if lamps are suddenly put down among small coal and dust, and left for a time while something else is attended to. Although the chances of fire are more remote in these cases, the fact remains that the incandescent lamp must not be regarded as entirely safe under such circumstances, and a knowledge of risks attending its careless employment should be instilled into those having charge of it.

In a recent issue of *Mines and Minerals* we also noticed some data on the ignition of coal dust by the means mentioned above. In one instance, with a slight covering of coal dust the lamp temperature rose in ten minutes to 370° F., and within four minutes the lamp exploded at a temperature of 450° F.

METALLIZED FILAMENT LAMPS.

SINCE the announcement of the radical improvements possible with ordinary carbon filaments for incandescent lamps, considerable interest has attached to their development and exploitation. As we stated in this section in our August issue an efficiency of 2.5 wat's per candle was obtainable with these lamps, and the makers claim that this figure can be maintained over a very high average of lamps. The new filament possesses a peculiar characteristic in that it flashes up quickly when turned on above its normal candle power and at once falls to its rated maximum. With the ordinary incandescent lamp the reverse of this happens, the lamp rising quickly until its normal candle power is reached. A highly valuable characteristic of the filament is its ability to resist higher temperatures, the special process of manufacture giving it this property. In practice it means that the filament is less affected by voltage variations and is not consequently so easily burned out, and further the fact that higher temperatures can be successfully applied minimises the risk of blackening the lamp bulb. It is claimed that the net efficiency gained is twenty per cent. over the



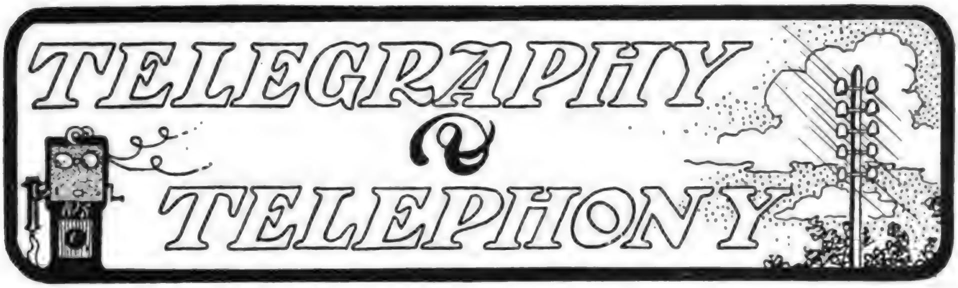
present highest standard incandescent lamps. This gain will be better understood by reference to the adjoining curve which graphically portrays the difference. We shall hope to have an early opportunity of reporting further on the efficiency of these lamps.

ARC LAMP ECONOMICS.

AN extended study of the behaviour and economics of arc lamps has recently been published in our German contemporary *Elektrotechnische Zeitschrift*, and in a subsequent issue we may be able to deal at length with some of the data put forward. At the moment the following table comparing the amount of energy consumed by different numbers of lamps in series will be of interest.

ORDINARY CARBONS.		
110 volts ..	2 lamps in series ..	1250 watts.
110 volts ..	3 lamps in series ..	1060 watts.
220 volts ..	4 lamps in series ..	1575 watts.
220 volts ..	5 lamps in series ..	1350 watts.
220 volts ..	6 lamps in series ..	1350 watts.
FLAME ARC LAMPS.		
110 volts ..	2 lamps in series .	800 watts.
220 volts ..	4 lamps in series ..	950 watts.
220 volts ..	5 lamps in series ..	1000 watts.

It appears that at the higher voltage the same number of lamps is less economical than on the lower. Flame arcs consume no more energy on alternating than on direct current circuits, but open arcs are very different. At 110 volts three in series alternating consume 60 to 70 per cent. more energy for the same light than do direct current lamps similarly connected; with two lamps in series the alternating current lamps take 40 to 50 per cent. more energy than do direct current lamps. On the score of energy consumption alone enclosed arcs are more extravagant than open or flame arcs, but when carbon consumption, attendance, interest and depreciation are included, it shows superior to the open arc.



For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

A Comparison of the Great American Telephone Interests.

THE average user of telephones in Great Britain has settled down to the belief that the present service is not likely to be improved now that the National Telephone interests will soon become those of the State. Placed beyond the stimulus of a keen competition such as might have been productive of good had the municipalities remained in the field, the telephone service in this country bids fair to continue in its present inefficient condition for many years. In America things are different. The older monopolists have long been put on their metal by a rival organization which is giving better and cheaper service both in and between States and threatens to obtain the ascendency over the pioneer concern by sheer weight of efficiency alone. The following article sums up clearly the telephone situation in the United States, and its general terms should make it of interest to the ordinary reader. It is taken from our enterprising contemporary *Telephony*, and is from the pen of Mr. M. B. Overly.

"From an exchange standpoint it seems to me that the fact that there are almost twice as many Independent telephones in Ohio as there are bell telephones is a slight indication that the service must be all right. In asking the question as to how the service of one company compares with that of another company, one naturally wants to know how the facilities of the two companies compare.

"Our friend, the Bell company, has been in business a great many years and has developed apparatus that is first-class. Their transmitters are excellent. Their receivers are just as good. Their switchboards are the finest and best that man can design and money purchase. They select fine poles and pure copper wire, and employ only the best construction men that can be secured. They also select their managers and operators with care. A combination such as this should give the finest kind of service.

"Now you ask what are the Independent companies doing? In the cities of Cleveland, Akron, and Toledo to-day I am quite sure that if you were to blindfold the average man and allow him to talk over either telephone, he could not tell you which one he was using. If you use both services daily, however, you will notice a great deal of difference. The Independent telephone is much more sensitive and distinct. The operator answers more quickly and does not call you so often when she wants someone else. In the larger cities the difference is not so perceptible as in the smaller towns. In more than ninety per cent of the towns and cities where both services are given, the Independent company has the most subscribers, the ratio often being as high as ten to one.

"Up to the last three or four years, it was very difficult for an Independent company to purchase first-class telephone and switchboard apparatus on account of patent litigation. Very few Independent men knew anything about how a plant should be built and maintained, and still less about operating it. This is all past now. Independent manufacturers can and do build as good and better telephones and switchboards than the

Bell manufacturers. Independent men have learned how to build a good plant and how to maintain and operate it. An official in the employ of the Bell company told me a short time ago that he considered the construction work done by some of the larger Independent companies superior to any ever done by the Bell. Nearly all of the Independent plants that were poorly built are being reconstructed and in the best manner possible.

"Competent employes were at first hard to secure. Good and experienced men could not be induced to leave a position that was sure for one that was simply an experiment. Time, however, has made a lot of competent employes who have grown up from the Independent ranks, and a great many Bell men have gone into the Independent service because they recognise its permanency and its wide field of influence.

"In considering this question from a long-distance or toll standpoint, I think there are comparatively few people, other than those connected directly with either the Bell or Independent companies, who know anything about what strides are being made toward the development of a system of Independent toll lines that will in a very short time reach across the United States. Most people are familiar with the fact, however, that when they wish to talk with anyone in their own state, no matter whether the person called for lives in a large city or at some country cross-roads, the only sure way to reach him is over the Independent lines. Our friends, the Bell, never contemplated the building of a system that would reach all of the people. It was not until Independent telephone companies were organised that this was made possible.

"Now when you consider that almost every state is being developed in that way by Independent people you will agree at once that the local toll business is being taken care of by them in a most satisfactory manner. I think you will also agree with me that to make a vast system out of this Independent development, all that is needed is trunk lines built of large copper wire between the larger cities, thus connecting this network of local toll lines and exchanges. Arrangements have been completed to build a number of these heavy trunk lines this year as well as to increase the number of local toll lines, so that within a comparatively short time it will be possible to talk between points in New York State, Pennsylvania, Maryland, West Virginia, Ohio, Indiana, Kentucky, Michigan, Illinois, Missouri, Tennessee, Wisconsin, Minnesota, Iowa, Nebraska, Kansas, Arkansas, and even Texas, and at the same time to get as good or better service than is now being given by the American Telephone and Telegraph Company. The service now given on the various Independent systems is regarded as superior to that of their competitors.

"To sum it all up, therefore, it seems to me that the service that is and always will be the most valuable to the telephone user is the service that reaches all of the people. This must be done at a reasonable cost and without taking up too much of the time of the person desiring to use it. The United States Postal service is popular because it fulfils these requirements. The United States Government is popular because it is a government of the people, for the people and by the people. The Independent telephone service is popular and successful for the same reason."

The Kellogg Common-Battery Telephone System.

The telephone system installed in one of the Keystone Telephone Company's exchanges in Philadelphia by the Kellogg Switchboard & Supply Company is shown in the accompanying diagram. At the subscriber's station, when the receiver rests on the hook, the bell and condenser are in series across the two-line wires, and hence the bell can be rung by the ordinary alternating current used for ringing purposes. The receiver is short-circuited, and the transmitter, *T*, and an impedance or choke coil, *I*, are on open circuit. When the receiver is removed from the hook, the impedance coil and transmitter are connected in series across the two-line wires. In parallel with the impedance coil is a circuit containing the condenser and receiver. Current from the central office battery cannot flow through the receiver on account of the condenser in series with it, but it can readily flow through the impedance coil and transmitter, little or none of it passes 25 ohms, is designed to allow the transmitter to receive the requisite amount of current from the central office battery to properly operate it. The higher frequency voice current arriving

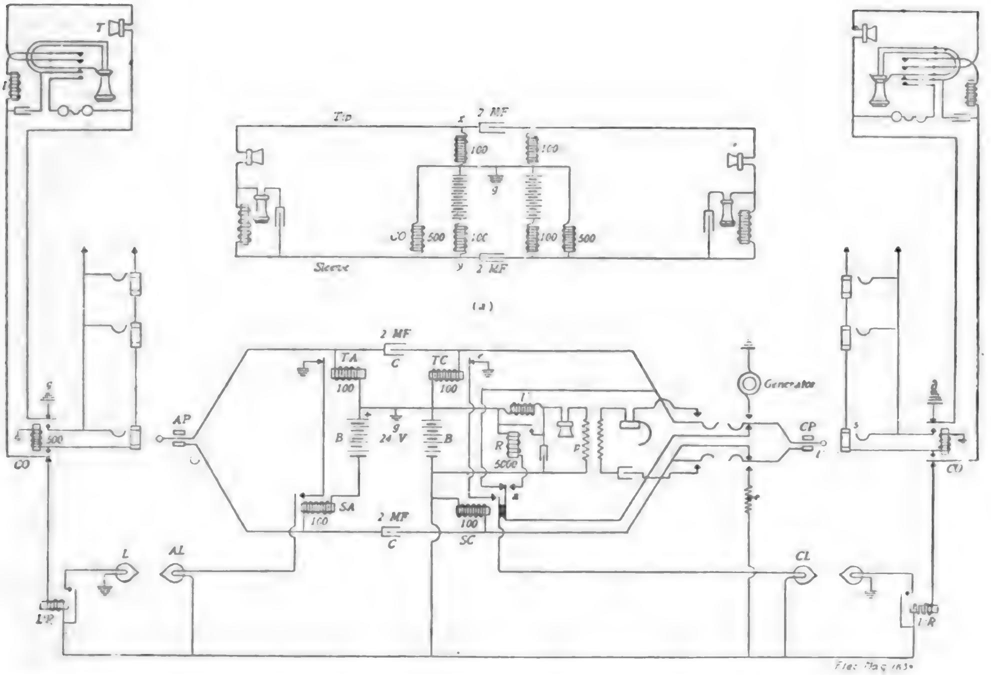


DIAGRAM OF COMPLETE CONNECTIONS OF A MODERN CENTRAL BATTERY TELEPHONE SYSTEM (Kellogg).

from the line passes through the condenser. receiver and transmitter, little or none of it passes through the impedance coil, because it offers, on account of its inductance, a much greater opposition to such a current than the condenser and receiver. Talking into the transmitter produces a rapid fluctuation in the strength of the battery current in the line circuit, thus affecting the distant telephone.

The exchange circuits operate as follows: When the receiver rests on the hook the condenser in the subscriber's instrument prevents the flow of battery current through the subscriber's telephone; but when the receiver is taken off the hook, sufficient current flows from battery $+B'$ through $g — g' — T — I$ — line relay $LR — B'$ to cause LR to attract its armature, thus causing the line lamp, L, to light. The operator replies by inserting the answering plug, AP, in the proper jack and closing the listening key.

Current will flow from B through g — cut-off relay, CO — sleeve side of circuit — relay SA back to B, which causes the 500-ohm cut-off relay CO to attract its armature, thereby cutting out the line relay, LR, which in turn extinguishes the line lamp and also connects the two line wires to the jack. Current can now flow and close both the supervisory relays SA and ST, because the line circuit is closed at the subscriber's instrument. The closing of the relay, ST, opens the circuit through the answering supervisory lamp, AL, and thus prevents the lighting of the latter at this time. The operator can now communicate with the subscriber. The operator's receiver and a condenser are connected in series across the cord conductors, but there is also a condenser, CC', in each cord conductor between the operator's head set and the subscriber's line circuit.

The operator proceeds to complete the connection by touching the tip of the calling plug, CP, to sleeve, s, of the jack belonging to the line wanted. If the line is busy, due to a plug being in a jack of that line at some other section, a click will be produced in the operator's receiver in the following manner: Current flowing from a battery through a 100-ohm relay—sleeve side of some cord circuit —sleeve, s,—tip, t' of calling plug—a— 5,000-ohm test relay, R, to ground, causes R to close its circuit, which short-circuits the impedance coil I'', thus producing a sharp

increase in the current through the primary, *p*, which causes a click in the operator's receiver. The operator then informs the waiting subscriber that the line called for is busy. If the line is not busy, *s*, as well as *t'* will be at the same potential as the ground; relay *LR* will not be affected and no click will be produced. If the line is not busy the operator inserts the plug in the jack, which will operate the cut-off relay, *CO'*. She then opens her listening key and closes her ringing key.

Current now flows from *B'* through the ground — cut-off relay, *CO'* —sleeves, *s*, of jack and plug — resistance, *r*, back to battery, thus holding the cut-off relay closed while the ringing current flows from the generator through the tip side of the line —subscriber's bell and condenser—sleeve side of the line—resistance, *r*—battery *B'*—ground to generator. When the ringing key is released, current flows from *B'*, through ground—cut-off relay, *CO'*—sleeve, *s*, of jack and plug—relay, *SC*—back to battery, which keeps both relays, *CO'* and *SC*, closed. The closing of *SC* causes current to flow from *B'* through ground —*e*— calling the supervisory lamp, *CL* (which it causes to light) to battery. The lamp, *CL*, will remain lighted until the subscriber called takes his receiver off the hook. Current can then flow from *B'* through relay, *TC*—*t'*—tip side of line—subscriber's transmitter and impendance coil —sleeve side of line—*s*—relay, *SC*—back to battery. This causes the relay *TC* to close, thus opening at *e* the circuit through the calling supervisory lamp, *CL*, which is an indication to the operator that the called subscriber has answered his telephone call. All three relays—*CO*, *SC*, *TC*—are now energized, and the condition of the circuit while the two subscribers are holding a conversation is shown at (*a*).

It will be seen from this diagram that each subscriber's circuit is supplied with current from a separate battery, there being a 100 ohm relay, which also acts as an impedance coil, between each terminal of each battery and the line wires. The battery and one of these relays on each side of the cord circuit are shunted by a 500 ohm cut-off relay whose resistance is sufficiently high not to deprive the line circuit of all the current necessary for the operation of the transmitters, and yet not too high to cause this 100 ohm relay to open when the receiver rests on the hook switch.

As stated, each subscriber's transmitter receives current from a separate battery through two inductive resistances, that is, relays. A fluctuation of current in the original subscriber's circuit produces a similar fluctuating difference of potential between points, *x y*, which will produce a fluctuating charge upon the two condensers, *C C*, which will, in turn, produce a fluctuating flow of current through the called subscriber's circuit.

When the subscribers hang up their receivers, the supervisory relays, *TA* and *TC*, are deprived of current and hence release their armatures, which cause the supervisory lamps, *AL* and *CL*, to light, thus notifying the operator that she should pull out the plugs, which restores the circuit to its normal condition.—*American Electrician.*

Some Problems in the Wireless Transmission of Signals: a Correction.

September Issue, 1905, p. 162, col. 2, lines 6 and 5 from end: *for* "receive another message" *read* "transmit another message."

The mistake arose from the fact that in the abstract of the discussion on Messrs. Duddell and Taylor's paper, given in the *Electrician* of June 16th, Capt. Jackson's remarks are incorrectly stated. Although the actual achievement, therefore—the *reception* of signals on one mast while another message was being *sent* from another mast on the *Vernon*—marks a considerable advance, the great difference in wavelength must be borne in mind.—L. H. WALTER.

Telegraphy Correspondence Class.—VIII.

Conducted by CICERONE.

[*These notes, through pressure on our space were omitted from the October issue.*]

"Treyar's" ambition is most praiseworthy, and under the peculiar circumstances in which he is placed he is pursuing the right course for the attainment of his object. If it is possible for him to sit at the examinations held under the City and Guilds Institute or the Board of Education at some neighbouring town where such examinations are held he ought to do so. The possession of certificates from these institutions is very valuable and always carries weight in company as well as in Government employment. They can also be utilised as levers for furthering one's interest if one feels that his claims to recognition are being ignored by his immediate superiors. At any rate, the obtaining of educational certificates can do no harm and may possibly do much good.

On the other hand, if it is impossible for him to attend at examinations under the auspices of these august bodies, he can't do better than

prepare himself for future examination by continuing to study by means of the Correspondence Class, and aim at securing one of the prizes connected therewith. That may bring his name forward in a manner unexpected, but nevertheless pleasing and satisfactory.

With regard to admission into the Institution of Electrical Engineers, of which he asks some questions in a letter to the Editor, we have pleasure in giving him the following information.

Candidates for election as members, associate-members, or associates must supply information as to their education as electrical engineers or electricians, their subsequent employment (stating year of commencing and leaving each position or appointment), their present appointment or occupation, and any additional information in support of their application.

Candidates for membership must be at least twenty-five years of age and must come within the following description, given in brief:

He shall have been educated as an electrical engineer or electrician in a manner which shall satisfy the Council, and either shall have had subsequent employment in the application of electricity for at least five years in situations of superior responsibility, and shall be actually engaged in such a situation at the time of his application, or shall be in practice and shall have practised on his own account in the profession of an electrical engineer or electrician for at least five years, and shall have acquired sufficient eminence in the same, or he shall be so prominently associated with the objects of the Institution, that the Council consider his admission to membership would conduce to its interests

Associate-members must be at least 25 years of age, and either electrical engineers or electricians, having been educated as such in a manner which shall satisfy the Council, and shall have had subsequent employment for at least two years in a responsible situation as an electrical engineer or electrician, or have been engaged for at least five years in one of the branches of electrical engineering, and shall afford satisfactory proof to the Council of his fitness for election.

Associates shall be persons more than 21 years of age who are interested in, or connected with, electrical science or engineering, or who are so associated with the application of electricity that the Council consider their admission as associates would conduce to the interests of the Institution.

The annual contribution of a member is three guineas, and of associate-members and associates two guineas. Candidates must be proposed and seconded by two members, and supported by three members, or two members and two associate-members.

One member must propose and another second candidates for associate-members or associates, and two members or one member and two associate-members must support a candidate for associate-membership, while two members or three associate-members or associates must support an associate.

The advantages of becoming a member or an associate are many. Members of each class are entitled to copies of all the Transactions and Journals of the Proceedings as well as to admission to the lectures and to the library. These latter benefits affect the London members mostly, but in several provincial towns sections have been opened at which papers are read and discussions conducted. There are very few associates or members amongst the rank and file of telegraph clerks, but this makes the honour all the more worthy, and should inspire our correspondent with the determination to be admitted upon his merits at the soonest possible moment.

Wooden poles when exposed to the elements are liable to be attacked by dry and wet rot. The former is a sort of fungus, and is somewhat rare, but the latter is common to all classes of timber at the wind and water line (*i.e.*, the ground line) unless the timber is in some manner preserved against its effects. Such preservation can be effected either by external or internal application, but they both aim at destroying vegetable life and promoting the evaporation of sap.

External application takes the form of seasoning or exposing the wood to draughts of dry air, so as to expel the sap, or to charring, which fulfils the same purpose in a more rapid and vigorous manner. It is accomplished by gently roasting in a slow fire, and afterwards tarring, the butt end of the pole to some distance above the ground line.

There are two modes of internal treatment, one of which, by introducing a metallic salt into the pores, destroys the sap and the vegetable life, while the other, by the application of an antiseptic oil, renders the wood waterproof. The latter process, which has perhaps given greatest satisfaction, consists in applying creosote to seasoned wood by forcing this product of coal tar into the wood from an air-tight cylinder.

Poles treated in this way have proved almost impervious to moisture, and have been most durable, but their smell is sometimes objected to, and they have a deleterious effect upon the gutta-percha of wires insulated with that material, and their surfaces won't take on paint. For certain purposes, therefore, timber so treated cannot be employed.

Of the other modes of internal application, burnetising, kyanising, and boucherising are the only three that have been given a practical trial. The process of impregnating a pole with chloride of zinc, by allowing it, when seasoned, to soak in a solution of that substance, is called burnetising, and poles so treated are sometimes used in towns where they are

D

required to be painted. The same process of soaking in a solution of corrosive sublimate, otherwise perchloride of mercury, is known as kyanising, but owing to the poisonous properties of the solution this system is not now used.

Boucherising has certain advantages over all other methods of treatment. It can be applied where the wood is cut down and when the timber is green. An injection of sulphate of copper is applied from a height to one end of the pole until the solution oozes out at the other end. The copper solution has a destructive effect on the ironwork of the pole, but otherwise the system is perfectly satisfactory, and has found much favour.

Walt's answers are marked by great precision and conciseness, and he will, no doubt, by a little industry take a foremost place amongst our monthly contributors. His budget arrived in good time, but his answers have not been specifically referred to, as the September notes, together with the replies now given, form a very complete summary of the subjects under review.

1. (*a*) A strut is a support affixed to a pole in such a manner that it resists the compressive strain thrown upon it by the forces acting on the pole.

A stay is an attachment which exercises a tensile stress or pull against the forces acting on the pole.

As, however, a strut is made of a solid, such as a piece of wood, it will withstand tensile as well as compressive strain. A stay, on the other hand, being composed of a wire (or wires) will only withstand a pulling strain.

1. (*b*) Considerations of space at the foot of the pole would be the main guide, but, as a general rule, a stay would be used in preference to a strut. As, however, a stay must necessarily be fixed on the side of the pole opposite to the direction in which the pole tends, it sometimes happens where the line of poles is erected along a roadway, or by the side of a canal, that a stay cannot be fixed on the proper side of the pole, and a strut on the other side would be used.

2. (*a*) A strut should be fitted to a pole by scarfing the end of the strut to fit the curvature of the pole, and the junction should be tarred or painted to render it watertight. The strut should be secured to the pole by a bolt passing through both. The lower end of the strut should be buried in the ground to a depth of about four feet, and a creosoted block fixed crosswise at the bottom. Halfway between the ground line and the point where strut and pole meet a galvanised iron rod is passed through both, and secured at each end. The strut should meet the pole as nearly as possible at the resultant point of the forces tending to move the pole from its upright position, and should form the widest possible angle with the pole.

2. (*b*) A hole about four feet deep, according to length of pole, is well undercut, and into the latter part is placed a block of preserved timber, having previously bolted to it a galvanised iron rod, with a thread at the extremity which projects above the ground. Screwed to this thread is an adjustable, tightening swivel, having an eye, through which a stranded wire rope is passed and spliced back on itself by separating its strands and placing them in a position parallel to, and surrounding, the wire rope. The wires are then taken singly in turn, and wound tightly round those remaining. At the resultant point, the stay is attached to the pole by a double noose, which is secured with staples, and the end spliced as already described. The earth should be well rammed on being replaced into the hole. As the strain on the stay varies inversely as the distance measured along the ground between it and the pole, an angle of 90 deg. should, if possible, be formed.

3. (*a*) Telegraph poles are protected from lightning by a wire projecting above the hood of each support, and continued down the latter to earth, where it terminates in a spiral of two or more turns.

3. (*b*) It is an open question whether the use of earth wires on poles lowers to any extent the insulation resistance of a wire, seeing that the leakage has to take place across the surface of the insulator itself, and the insulation resistance of the insulator is unaffected by the presence or absence of an earth wire. So far as the insulator itself is concerned it is a matter of indifference whether the leakage current gets to earth direct or via the neighbouring wires. As, however, the conductor resistance of the earth wires is less than that of the other wires on the pole, the result may be that the actual insulation resistance of a line wire is decreased by the practice of earth-wiring poles. There is no doubt that the presence of earth wires on poles increases the electrostatic capacity of a wire, the reason being that as the capacity of a condenser varies inversely as the thickness of the dielectric between the plates, so will the capacity of a telegraph wire increase when the distance between the wire and the earth is decreased by (practically) bringing the earth nearer to the wire by means of the earth wire, the latter being a good conductor, and at earth potential.

(This answer is well reasoned out, but the insulation resistance of a pole having an earth wire is undoubtedly reduced, as the wire provides an easy path for the escape of leakage from the insulator to earth, compared with the pole itself.)

4. (*a*) Norwegian or Swedish red fir, felled in the winter months when free from sap, is now almost exclusively used for telegraph poles.

4. (*b*) Chief objections to iron poles :—

Dearness.

Good earth in case of faulty insulators.

Increased electrostatic capacity and electro magnetic inertia of line.

5. (*a*) Ebonite comes first with regard to high insulation, but exposure to rain causes its surface to become roughened and spongy, which considerably reduces its insulation in wet weather, so that it is unsuitable as an insulator for aërial wires. For indoor work, such as insulating the different parts of instruments, it is the best material of those quoted. Porcelain takes fifth place on the list in resistance as an insulator, and first for open-air work. It also finds a prominent position in doors by supporting batteries and heavy instruments placed on the floor that have to be carefully insulated. Although glass has a higher specific resistance than porcelain, its use, except in extremely dry climates, is precluded, owing to its hygroscopic nature, whilst sudden heat causes it to crack. Earthenware stands the weather well, and is much cheaper than porcelain; it has, however, with the exception of wood, comparatively the lowest specific resistance. Paraffin and gutta-percha take second and third place respectively as regards resistance. The former, on account of its high dielectric capacity, is used with dry paper as the insulating medium between the plates of condensers. It is also mixed with wax for the purpose of covering exposed wires underneath telegraph instruments. Gutta-percha deteriorates rapidly when exposed to the air, but is an excellent material for insulating wires leading to instruments from outside, &c. For submarine cables it has no rival, as its insulation is extremely high, and appears to be imperishable in water. Unfortunately its dielectric capacity is considerable, coming third on the list in that respect, glass and paraffin being first and second in the order mentioned. Wood is cheap and fairly durable, but is easily affected by dampness, and has not the highest of specific resistances.

5. (*b*) Iron wire is protected from chemical action by giving it a coating of zinc, the process being known as galvanising. The wire, after being rolled to the required gauge and cleaned in a bath of hydrochloric acid, is passed through a trough containing molten zinc, which adheres to the wire, and when cool forms a protective covering.

In Germany the wire is passed white hot through an oil bath, which practically gives it a coat of varnish.

Taking the specific resistance of iron as being 6.5 times that of copper, then from the formula

$$\frac{R_1}{R_2} = \frac{l_1 d_2^2 S_1}{l_2 d_1^2 S_2}$$ we get (R and l being equal)

$$\frac{d_2^2}{d_1^2} = \frac{6.5}{1}$$

$$\therefore \quad \frac{d_2}{d_1} = \sqrt{\frac{6.5}{1}}$$

∴ diameter of the iron wire would be 2.54 times that of the copper wire.

The following is another method of obtaining the same result :

Let d = diameter of copper wire.

„ D = „ iron „

From formula :— $R = \frac{l\,s}{a}$

But the resistance and length are equal, so that

$$\frac{S}{d^2} = \frac{S_1}{D_2}$$

where S and S_1 = specific resistance of copper and iron respectively.

Let $d = 1$

Then $\frac{.6433}{1^2} = \frac{3.825}{D^2}$

And $D = \sqrt{\frac{3.825}{.6433}} = 2.4$ approximate.

Answer as 1 : 2.4.

6. (*b*) The height of poles along a roadway is regulated by the height of the obstacles to be surmounted, and on main roads should be at least 22 feet. On branch roads 20 feet may be allowed. The poles should be as far as possible uniform in height from the ground, so that when surmounting a hill, for instance, the line of wires will follow the rise and fall of the ground. On railways 20 feet from the ground is the usual height, although on branch lines where few wires are carried this height may be decreased to as low as 16 feet. The lowest arm on the pole should be 12 feet from the ground, but at crossings, either road or rail, 20 feet should be allowed from the ground to the lowest wire, in order to effectually clear high loads passing under.

In underground construction different principles are involved altogether, and the same regard for mere strength does not become necessary, although efficiency and durability are quite as, if not more, essential. The conductor, being buried at a considerable depth below the surface of the earth, is immune from those sudden strains and stresses to which a line erected overhead is subjected, but the subterranean system has troubles of its own, which necessitate the greatest possible care being bestowed upon every operation in order that they may be eliminated or reduced. First, there is the digging of a trench, at a sufficient depth to protect the conductor and its envelopes from damage by downward or from severe lateral pressure, and from extremes of temperature.

If cast-iron pipes are to be used for containing the sheathed conductors, they should be buried at least two feet deep, and should avoid changes in direction and in level. The

bottom of the trench should be made hard and smooth, with hollows excavated for the sockets to rest in.

The pipes are made from good pig iron, carefully rimed inside and tarred outside, in lengths from 6 ft. to 9 ft., and with an internal diameter of from 2 in. to 4 in.

Three of these lengths are usually jointed together before being laid in the trench, the spigot end of one being fitted into the socket of the next, and the annular space between filled in with a packing of yarn, over which is laid a layer of plastic clay, and finally a caulking of lead. Each section thus laid is cleaned inside with a mop of yarn, and threaded with a pulling-in wire or rope.

Iron pipes are more expensive and less durable than modern conduits, and they are being superseded by the latter, especially in cases where more than one or two pipes are required. The material used in the manufacture of conduits should be durable, incorrodible, and not affected by gases or chemicals in the soil. It should also be fairly cheap, and possess sufficient tensile, shearing, and crushing strength, as well as be a good waterproof and fireproof insulator. They are made in a variety of forms from clay, terra-cotta, cement, earthenware, concrete, &c., &c. The oldest form was of the wooden trough order, but wood is never now used, even when it is well creosoted, as the acetic acid liberated from the wood causes infinite trouble.

Ducts are made singly or in multiple, the latter being most economical when there are a number of cables to be accommodated, but they are not so flexible as the single ducts. They are generally laid on a concrete bed, in about 2 ft. lengths, one section being laid on top of another until the required number are formed. The most popular is the octagonal shape with circular bore, but the arch shape is perhaps best, as it allows foreign matter to sink to the corners, and renders withdrawal easier and less liable to abrasion.

Jointing is done in a variety of ways, but one of the best is to surround the abutting ends with a strip of prepared calico soaked in ozokerite, which renders it adhesive, and makes a good joint.

Conductors are always of copper, the weight differing with the requirements of the circuits, and gutta percha or indiarubber have been the chief insulating materials used up to quite recent times.

Gutta percha is best for subterranean and submarine purposes, but it deteriorates when exposed to changes of temperature and to moisture. Indiarubber is more durable in air than the former. For telephone work cables are made up in quads, *i.e.*, four wires twisted together.

But the best of all cables is the paper-covered, lead-sheathed cable of recent times. It has the advantage over others of economy in cost and in space, durability, insulating properties, and electrostatic capacity. Copper forms the material for the conductor, but the insulating material is a thin layer of specially dried paper, applied either longitudinally or spirally, and the conductors are usually twisted in pairs, with lays depending upon the gauge of the wires. The pairs are then laid up symmetrically into cables, each pair sometimes being protected with an additional covering of paper, and all adjacent layers revolving with an opposite twist. Thus prepared the cable is next wound on an iron drum and placed in an oven, at a temperature sufficient to drive out all moisture but not sufficient to carbonise the paper. When thoroughly dried, it is passed through a lead press, from whence it emerges with a lead sheath or covering of required thickness. The finished cable is then wound on wooden drums and its ends sealed. Any defect in the lead envelope causes a general breakdown in all the conductors contained within, so that particular care is necessary in applying the sheath, and in making any joints or repairs. As the lead acts as a mechanical protection for the conductors and is liable to accident when buried in the earth, besides being chemically acted upon by certain classes of soil, it must itself be protected by means of an iron pipe or earthenware trough such as already described.

The phenomenon known as electrification which manifests itself when testing gutta-percha or india-rubber cables, is entireiy absent in the case of paper-covered ones.

In all classes of subterranean and submarine telegraphy the work of jointing is of the highest importance and demands the utmost care, but in multiple dry core cables it has become reduced almost to a fine art. Cleanliness is always a desideratum and the physical condition of the jointer is regarded as an important factor in the satisfactory jointing of gp cables, but all this as well as a high intelligence and general resourcefulness become necessary when paper cables so-called are dealt with. The absolute necessity for the expulsion of all moisture from inside the sheath renders many precautions necessary and one little bit of carelessness or indifference might lead to a multiplicity of troubles.

EXERCISE VIII.—NOVEMBER, 1905.

I.—Define clearly the difference between a stress and a strain.

II.—Give a general indication of how you would proceed to survey a route preparatory to the construction of a telegraph line.

III.—Write a short essay on overhead line construction.

Answers should be sent in early in December as that issue will appear sooner on account of the Christmas holidays.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

Electric Furnaces.

By J. H. STANSBIE, B.Sc., F.I.C.

THE main object of this paper is to introduce some simple forms of electric furnaces which can be readily fitted up for experimental purposes. The literature of the subject is rapidly becoming voluminous, especially that which refers to the specifications of patents. Every known principle seems to have been appropriated in the hope that something useful may be covered, but in spite of its many successes the application of the electric furnace for industrial purposes is still in its infancy, but there is much hope for its future.

Electrical energy may be converted into heat in a variety of ways, and the chief of these have been utilised for electric furnace work. Electric furnaces may be divided into two main classes, (a) electro-thermic, in which the heat equivalent only of the electrical energy passing into the furnace is utilised for producing physical, chemical, and metallurgical changes; and (b) electrolytic, in which part of the energy of the current is used directly in effecting chemical changes, and the remainder for heating effects. The first class only will be dealt with in this paper.

There is only one direct way of converting electrical energy into heat, and that is by putting material resistance into the path of the current which is carrying it. This resistance may be furnished by either a solid, a liquid, or a gas. If the resistance is offered by solid or liquid matter, the apparatus is known as a resistance furnace; but if by gaseous matter, it is an arc furnace. A large number of furnaces, both experimental and industrial, arrange themselves under these heads, and there are several subdivisions according to the particular way in which the principles are applied. In the majority of these furnaces the resistance is in the path of the primary current. There is, however, a resistance furnace in use which does not appear to have passed through the laboratory stage, but to have been developed at once for industrial purposes. It is based upon the transformer principle, and consists of a cored coil for carrying light alternating currents of high potential surrounded by an annular space or hearth lined with refractory material in which a continuous circuit of the metal under treatment carries the heavy induced currents of low potential, and offers the resistance necessary to develop sufficient heat for its fusion. Its best known form is the Kjellin furnace, although others claim to have introduced important modifications. Kjellin uses currents of 80 to 90amps, at a pressure of 3,000 volts in the primary, and 30,000amps at 7 volts in the ring of metal in the hearth, which has a capacity of 35cwts. of steel. Furnaces of this type having a capacity of a few pounds should prove very valuable for the preparation of pure metals.

At present the ideal source of the mechanical energy for dynamos and alternators is water power, and where this can be obtained the electric furnace flourishes. The enormous loss of energy taking place between the stoker's shovel and the fly wheel of a steam engine puts the direct combustion of solid fuel out of court, but the use of gaseous fuel direct, especially of the waste gas from blast furnaces, will much improve the chances of electro-thermic processes being made successful generally.

It is estimated that about 500,000h.p.

developed from falling water is being used in electric furnaces for the production of aluminium, carborundum, calcium carbide, Graphite, iron, steel, ferro-alloys, &c. The Acheson furnace for carborundum, the Héroult furnace for steel making, the Stassano furnace for ore reduction, and the Keller furnaces, may be mentioned as being in use in successful industrial processes; while the number of furnaces being used for the manufacture of calcium carbide is very large.

Experimental Furnaces.

A small resistance furnace for demonstrating the melting of metals is readily made by chipping the large face of a firebrick so as to form the cavity and the two semi-circular channels running from it to the ends of the brick. A second brick with a shallower cavity and similar channels serves for the top. The cavity forms the hearth of the furnace, and the channels allow of the introduction of two carbon rods which are fixed with their

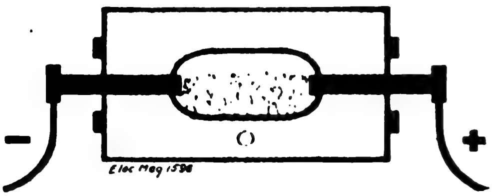


FIG. 1.

ends just projecting into the cavity. The metal is placed in the cavity and covered with a layer of small pieces of carbon so arranged as to fill up the space between the carbon rods. Arc lamp carbons broken up serve the purpose very well. The top is placed in position, and the current switched on. The temperature rises rapidly, and a charge of cast iron is soon melted. This can be run from an inclined tap hole passing through the bottom of the cavity, by plugging the upper end with a piece of the metal before charging. The metal plug melts last, and the whole charge runs from the furnace in a continuous stream. A vertical section of the furnace is shown in Fig. 1. A slight modification of this furnace enables it to be used with a carbon tube. An inclined channel is made in the walls of the hearth, at right angles to the length of the bricks, to hold the tube, the ends of which project from the sides of the furnace. The cavity is filled

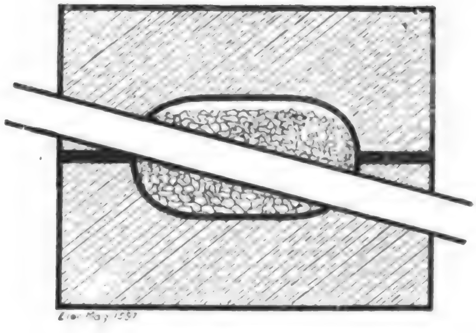


FIG. 2.

with carbon fragments to surround the tube and connect the rods. On passing the current into furnace a rapid increase in temperature takes place and substances to be experimented with can be readily introduced into the tube. Reductions and fusions are rapidly effected. The tubes are readily made by drilling pieces of arc carbon of requisite length. See Fig. 2, which shows the furnace in vertical transverse section.

A small arc furnace of the Siemens type is easily fitted up. A hole is drilled in the side of a carbon crucible and a carbon rod fitted tightly into it. The crucible is placed in a cavity in a fire clay block which also supports the carbon rod along part of its length. The block is placed on a small iron table having a vertical rack motion, and a carbon rod to

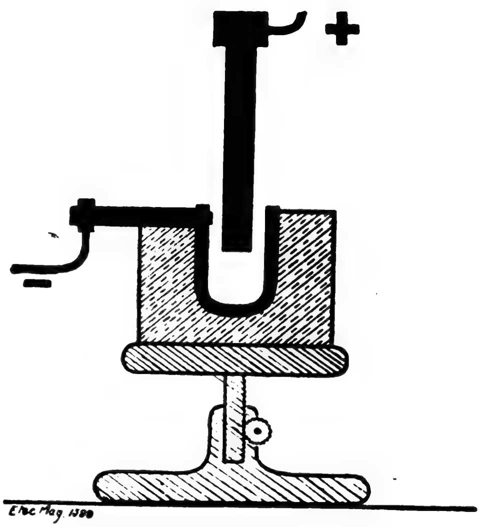


FIG. 3.

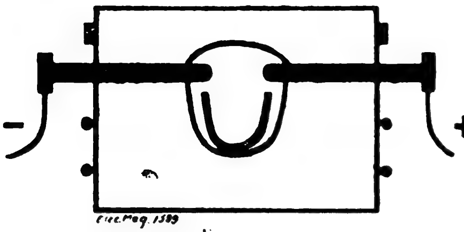


FIG. 4.

act as the positive electrode is fixed vertically over the crucible. When the charge has been introduced and the current switched on the arc is readily struck by raising and lowering the table. The operation can be regulated by the same means. Fig. 3 shows the furnace in vertical section.

A more durable form of the Moissan lime furnace (Fig. 4) can be made with strongly compressed magnesite bricks. Two of the bricks are chipped out on corresponding faces, so as to form the crucible cavity and the channels for the carbon rods. They are then braced firmly together, and the top formed by a third brick hollowed out a little to correspond to the cavity below. The electrodes are carbon rods 1in. in diameter and 15in. long, having copper electro deposited on part of their length to ensure good contact. The reactions are carried out in a shallow carbon crucible and the majority of the fusion and reduction experiments requiring very high temperatures can be made in it. Chromium and molybdenum are readily reduced from their oxides. The current used in these furnaces varies from 100 to 200amps at a pressure of 110 volts in the mains. One of the latest developments is that dealing with tantalum, the cheap production of which bids fair to mark an epoch in the history of incandescent lighting.—Abstract of paper read before Birmingham Electric Club.

Rapid Electro-Deposition of Copper.

In a recent paper read before the Faraday Society, Mr. Sherard Cowper-Coles dealt with the known methods of depositing copper and treating of a centrifugal process which greatly increases the rate of deposit without unduly raising the amount of energy required. The following have been extracted from the paper, and will be found of exceptional interest:—

"The author when carrying out experiments on the electrolytic production of copper tubes, which should be free from laminations, observed that if the mandrel constituting the cathode was revolved at a certain circumferential speed, smooth thick deposits of copper could be obtained at very high current densities, which could not be obtained by any other method. Further investigations were made to determine this speed. The method eventually adopted for determining the critical speed required under varying conditions was a cathode in the form of a cone, by which means the critical speed can be determined very readily. It has been found that the tensile strength of the copper increases with the speed of rotation.

"It is found that very pure copper is obtained by the centrifugal process, even when very high current densities are employed, and the solution contains much foreign matter in suspension, as shown by the following analysis of a copper sheet:

Iron	0.0189
Arsenic	0.0015
Lead	0.0013
Antimony	0.0010
Bismuth	0.0008
Silver	Absent
Nickel	Absent
Sulphur	Absent
Copper, by difference	99.9765

"The composition of the electrolyte usually employed is copper sulphate 10 per cent., sulphuric acid 10 per cent., water 80 per cent.

"In the ordinary process of copper refining, when a current density of about 1 ampere per square foot is employed, the copper is deposited in a corrugated form. The top of the nodules or excrescences forming ledges on which the impurities in suspension settle, and become ultimately sealed by the further deposition of copper, the circulation of the electrolyte not being sufficient to sweep them away; this difficulty is overcome in the centrifugal process, as any particles of impure metal detach themselves from the anodes, and gradually approach the cathode. As soon as they arrive within a certain zone of the cathode they are immediately repelled by the centrifugal action.

"Another great advantage of the centrifugal process is that the copper is free from lamination, such as is found when copper is burnished at stated intervals. This point has been established both by mechanical tests and microscopical examination. It has been found that any stoppage or great variation in the speed of the mandrel causes lamination. The nodules or excrescences that form on copper are nearly always due to a particle of dirt settling on the cathode or a bubble of gas adhering tenaciously, with the result that the copper builds up around the adhering substances rapidly increasing in size.

ESTIMATE OF COST OF WORKING PROCESS.

Estimated Cost of Plant for Producing 10,000 Tons of Tubes, Sheets, and Wire per annum by the Centrifugal Process.

Cost of 95 vats and accessories ...	£64,000
Machinery for finishing tubes, sheets, and wire	5,000
Cranes and lifting gear	1,500
Building	15,000
Plant for mandrel making	2,000
Machinery for fitting shop	1,500
Pumps, atomisers, filter tanks	5,000
Foundry	2,500
Driving machinery for vats	5,000
Conductors and electrolyte	5,000
	£106,500
Floating capital for copper	30,000
	£136,500

ESTIMATE OF COST OF PRODUCING COPPER TUBE, SHEET, AND WIRE BY THE CENTRIFUGAL PROCESS DIRECT FROM CRUDE COPPER.

Power per ton (2240 lbs.), 1015 kw. hours at 0.275 of a penny per kilowatt	£1	2	2
Wages, at 8d. per hour—18½ hours		12	4
Management		5	0
Interest on copper lock-up		1	0
Depreciation on plant and building		10	0
Heating electrolyte		1	0
Drawing and rolling		5	0
	£2	16	6

"Copper tubes produced by this process without any drawing have been given a maximum stress of 17 tons, and a tube after drawing has stood a pressure of 3,000 lbs. per square inch—thickness of metal 0.063 inch—without showing any signs of distress; and sheets, without rolling, have given a maximum stress of from 28 to 34 tons (2,000 lbs.) per square inch.

"The adjoining figures represent the actual working cost, on which there would be a further reduction for the precious metals recovered, and if £1 10s. be deducted from the above cost, which is at present the difference between Chili bars and electrolytic copper, the cost per ton is reduced to £1 6s. 6d.

"The following are some of the chief advantages claimed for the process: The copper is refined and manufactured into sheets or tubes in one operation, the copper being of a hard nature, similar to that which is cold-rolled; the process is at least ten times faster than any existing electrolytic process; a high current can be employed without deteriorating the quality of the copper; there is no risk of lamination, as no burnisher is employed; the plant is simple and free from mechanical complications; the amount of copper locked up for a given output is small compared to other processes; finally, anodes of very impure copper can be used as compared to the anode copper used in other systems."

COMPARATIVE DATA OF COPPER-REFINING WORKS.

Name of Works.	Max. capacity in lbs. and kilos. per day per H.P.			Terminal Voltage.	Current density amperes per sq. ft.	Current density amperes per sq. d.c.m.	Tank capacity in cub. ft. per lb. of copper per hour.	Tank capacity in cub. ft. of coppe per hour. Cub. dec. per gramme
U.S.A.	Lbs.		Kilos.					
Raritan........	100	..	45.359	0.37	15	139.35	7.1	0.443
Anaconda......	126	..	57.153	—	10.20	94.758	10.1	0.63
Guggenheim....	144	..	65.317	0.3—0.4	10	92.9	7.0	0.437
Baltimore......	170	..	77.111	—	—	—	—	—
Nichols........	—	..	—	0.1—0.2	—	—	5.3	0.331
Great Falls	—	..	—	—	30—40	278.7—371.6	—	—
Balbach........	125	..	56.699	—	12—16	111.48—148.64	—	—
ENGLAND.								
Bolton (Fryhall)	60	..	27.215	0.7—0.8	12	111.48	11.1	0.693
Leeds (Elmore)	26	..	11.793	—	—	—	8.75	0.546
GERMANY.								
Hamburg......	165	..	74.843	0.45	1.85	17.186	—	—
Oker..........	118	..	53.524	—	—	—	—	—
FRANCE.								
Biache St. Vaan	110	..	49.895	0.2	3	27.87	—	—
Marseilles......	110	..	49.895	0.2	1.24	11.52	—	—
RUSSIA.								
Halakent	44	..	19.958	0.34	3.7	34.373	43	2.683

Every aspect of the design and manufacture of electrical apparatus will be dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

Notes on Switchgear Controlling Apparatus.

By CHARLES C. GARRARD, Ph.D., A.M.I.E.E.

THE object of this article is to bring before readers some points in the apparatus dealt with from the designers' and manufacturers' point of view, and it is hoped that it may prove useful, especially to those who have charge of plant of which such gear forms a constituent part and accurate knowledge of which facilitates their operation and upkeep.

(A) Automatic Switches for Alternating Currents, Maximum Type.

An alternating current switch may be rendered capable of automatically opening the circuit when a current of certain magnitude flows through the same either by means of a simple solenoid or electro-magnet, or a device depending on the induction principle. With a small expenditure of energy and small voltage drop the larger force can be obtained by means of the electro-magnetic device, and for moderately high voltages, say up to 3,000 volts, a simple solenoid in the high tension circuit has much to recommend it. This is especially so for switches intended for mining work, &c., where simplicity and cheapness are the prime considerations. The disadvantage of this system is the difficulty of insulating the solenoid and, as the same is high tension, it should be entirely covered in. It is not wise either to allow for any adjustment of the point at which the switch is to open circuit; at any rate it should not be possible to do this while the solenoid is alive. As regards the dimensions of such solenoids it is found that for, say, a three phase (*i.e.*, three pole) 100 ampere switch a coil arranged to have, at the lowest current at which it should work, 1,000 to 1,800 ampere turns is sufficiently strong. It must, of course, have a nearly closed laminated magnetic circuit, the act of operation entirely closing this circuit.

For central station switchboard work such simple devices as the above are not to be recommended, and the arrangement which comes next to it, as regards low cost and simplicity, is that in which the solenoid, which provides the actuating force, is operated through a current transformer. This system can be used for any voltage, as the insulation of the current transformer is made sufficient, and safety of operation is ensured by earthing the solenoid winding. As the force required to open the breaker is the same as before, the design of the solenoid is identical with the above. A point to be remembered in this connection is that owing to the considerable self-induction of such a tripping coil, it is necessary to take certain precautions if it be desired to operate any instruments off the same series transformer as the trip coil. Thus if an ammeter be put in series with the coil its readings will vary with the position of the iron plunger in the solenoid. To get over this a more expensive transformer—one having very little magnetic leakage—than is generally used for ammeters or relays, should be installed. Another way of getting over the difficulty would be to let the position of the plunger in the solenoid be fixed, in which case it would not be possible to vary the current at which the cut-out operates, which is, of course, a disadvantage. When purchasing such an apparatus, therefore, it should be specified that the ratio of the transformer should not be changed by moving the plunger anywhere within its adjustable range.

What has been written above has sole

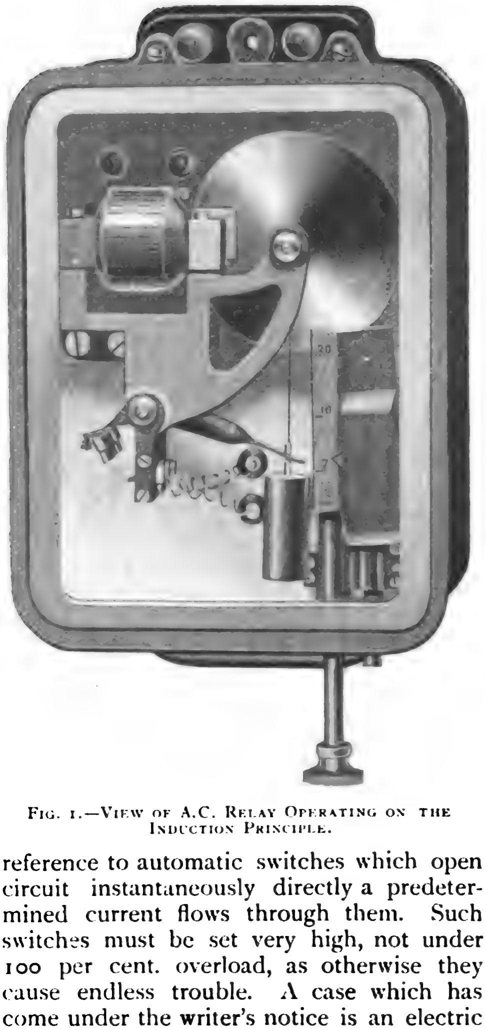


FIG. 1.—VIEW OF A.C. RELAY OPERATING ON THE INDUCTION PRINCIPLE.

reference to automatic switches which open circuit instantaneously directly a predetermined current flows through them. Such switches must be set very high, not under 100 per cent. overload, as otherwise they cause endless trouble. A case which has come under the writer's notice is an electric railway in which the generators are equipped with maximum current instantaneous action circuit breakers. Whenever a short occurs on a car, the generator circuit breakers open circuit in spite of the fact that transformers and rotaries with their switchgear come between them and the short. The consequence is that the automatic gear is pegged up and rendered inoperative.

In the majority of cases some form of time element has to be used, and for this we have to depend on a relay. For several reasons it would be of advantage if an alternating current circuit breaking device with time limit could be got out which did not need a relay. The practical difficulties in the design of such an apparatus for alternating currents seem, however, to have prevented this development. The path of least resistance in the development of a time limit maximum current relay has been the application of the induction motor principle, as by this means a rotary motion can be obtained easily and thus a lengthy action of the device secured. Fig. 1 represents such a relay as manufactured by Messrs. Ferranti, Ltd., and a somewhat similar device is made by Messrs. Brown, Boveri of Switzerland. The driving force in all these types of relays is obtained by means of a shaded pole. This consists of an alternating current electro-magnet with a gap within which the pivoted disc moves. The pole faces of the magnet facing the disc are divided into two parts, one of which is surrounded by a closed copper ring, as shown in the illustration, Fig. 2.

A simple qualitative theory of this apparatus is as follows: The current in the winding of the magnet causes a field to pass across the air gap, cutting the pivoted disc. As a result of this eddy current electromotive forces are induced in the disc, which electromotive forces lag 90° behind the inducing field. The fact that this 90° lag exists can be understood if one considers that the electromotive force induced will be greatest when the rate of change of the number of magnetic lines cutting the disc is a maximum, *i.e.*, when the magnetism is just reversing in direction, that is, when the curve of magnetism cuts the zero line. As the disc is practically non-inductive, the eddy currents will be in phase with the eddy E.M.F. We have consequently a field cutting a conductor in which currents flow which are 90° out of phase with this field; consequently, no mechanical force will be exerted. Besides, however, inducing currents in the disc, currents will be induced in the copper shading rings. These currents will be nearly in phase with the current in the

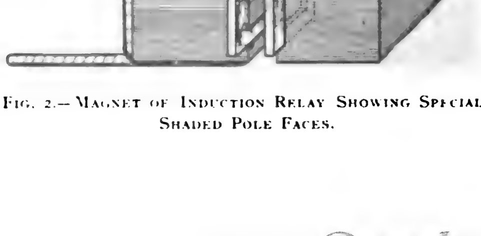


FIG. 2.—MAGNET OF INDUCTION RELAY SHOWING SPECIAL SHADED POLE FACES.

disc, and the secondary field through the disc due to the shading ring currents will be in phase with the shading ring current, and thus in phase with the eddy current in the disc due to the primary field. Thus mechanical forces are set up and the disc tends to move from that part of the pole face which is not surrounded by the copper rings to that part which is so surrounded.

Two curves showing the calibration obtained in a relay as illustrated in Fig. 1 are here given:

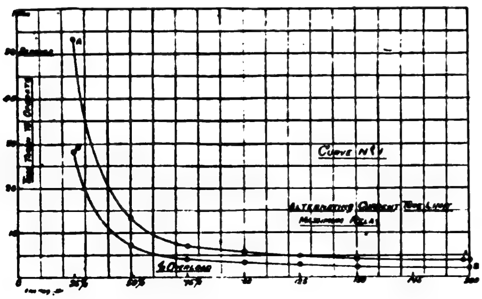


FIG. 3.—CALIBRATION CURVES OF INDUCTION RELAY.

It will be noticed that the time element is inversely proportional to the extent of the overload, which is, of course, rational. In the relay illustrated the time element is altered by moving the permanent magnet which damps the rotation of the disc; and the current at which the relay works can be varied by altering the suspended weight. In the Brown Boveri relay the latter adjustment is the same, but the time adjustment is made by lengthening or shortening the string by which the weight is suspended.

A practical example of the use of such relays is for the protection of a system consisting of feeders supplying a substation in which motor generators are running. At the supply station end of the feeders and in the substation between the motors and the bus bars, time limited maximum relays are installed. They must be set so that the motor generator relay operates before the feeder relay. To this end the writer would suggest that the time elements of the relays should be set as far apart as possible, *e.g.*, in the motors, say, 5 seconds, and in the feeders, say, 15 to 20 seconds. In considering such a question the complete calibration curves of the relays that it is intended to instal at the different positions should be studied, in order to see that under all conceivable conditions the cut-outs operate in the desired rotation. The two curves in Fig. 3 illustrate this point; they show that under no possible conditions would cut-out A (feeder) operate before B (motor).

Should a dead short come on, it is still necessary for the motor relay to work before the feeder relay and thus cut off the short, should the same be in the motor circuit, without shutting down the supply through the feeder. It is here that the advantage of the large difference in the settings comes in. In order to test this point the following experiment was made: Two identical relays (wound for 10 amperes) were taken and connected in series. They were attached to automatic switches and the time elements were 30 seconds and 3 seconds respectively. Sixty amperes were now suddenly switched on through the relays, this corresponding to a 500 per cent. overload. It was found that the shorter time element relay operated and opened its switch well before the longer one had time to close its tripping circuit, the actual time elements being as near as could be measured .7 seconds and 2.5 seconds respectively.

The voltage drop at full load across a 10 ampere relay, as illustrated in Fig. 1, is .6 volts, and the liberation of energy therein is 2.5 watts, the periodicity being 50.

(*To be concluded.*)

A Proposed Phase Regulator and its Applications.

By P. G. WATMOUGH, Junr.

[*The following article from the "Electrical World" bears on an important aspect of generator control that opens up possibilities which have nothing short of automatic regulation in view for large power stations.*—ED.]

ONLY the general principles and applications of this device are here presented, the actual structural details being immaterial for the purposes of this article. Briefly speaking, the apparatus consists of a selective device, responsive only to phase displacement, in combination with and actuating a relay mechanism, which controls or varies the field exciting current supplied to the generator or other alternating-current apparatus whose phase displacement it is desired to adjust through the medium of its field excitation.

Any form of selective device or phase-

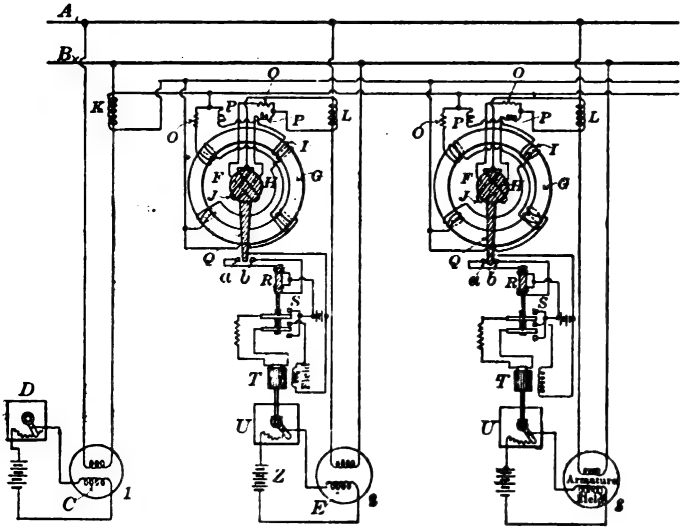


Fig. 1.

swing over a graduated scale, will thus directly indicate the phase displacement existing between the currents energising or exciting the two field structures. These currents may be derived from in dependent circuits or may be derived from the currents flowing in different branches of the same circuit. If one field member is energised by a current due to the impressed e.m.f. of the circuit, and the other member is energised by the current flowing therein, then the instrument becomes a power factor meter, for it measures the phase difference between the e.m.f. wave and the current wave.

indicator may, of course, be used—the one here proposed consisting of two magnetic field members placed concentric with each other; these are marked G and H in Fig. 1. The inner field or element is pivoted so that it can rotate through a considerable angle; this mechanical detail is not shown in the drawing. Polyphase field windings, preferably arranged for diphase currents, are placed on each member, so that a rotating field flux may be obtained in each structure when the windings are suitably energised. It is proposed to use a single-phase source of current to supply each polyphase circuit, the necessary two-phase effect being obtained by means of inductance and resistance suitably connected in series with the proper coils. If connections are made so that both rotating field fluxes revolve in the same direction, the magnetic structures will tend to maintain a fixed and stationary relation with respect to each other, the exact points of opposition being determined by the interaction and relative phase displacement of the fluxes circulating in each member.

Any phase difference between the current in the windings on member G and the current supplying the coils on H will produce a corresponding displacement between the interlocked rotating fluxes, resulting in a torque tending to cause member H to shift its position relative to G by an angular amount dependent upon the aforesaid lag or lead between the currents. An index arm mounted on H and arranged so that it will

In order that the instrument may be used as a phase regulator, the swinging index arm is equipped with a contact device arranged to close one or other of the two relay circuits, the energising of which sets in motion a motor suitably geared to the field rheostat of the machine whose field it is desired to control. The arrangement and mode of operation of the apparatus are more fully set forth in the description of the several applications to which the instrument may be put, which are herewith presented.

First, as a phase indicator or power-factor meter, the general mode of operation of which is outlined above.

Second, the automatic maintenance of zero phase displacement between generators or other alternating current apparatus operating on the same circuit. The phase displacement here referred to is that caused by unequal excitation. The displacement due to the speed variation of the prime movers, being of an oscillating character, will exert no appreciable influence on the phase regulator if the latter has a greater period of oscillation than the former. This relation can readily be obtained. Phase control by speed variation is discussed later.

The most economical operating condition requires that the excitation current of each machine should be adjusted to that value which will produce equal terminal e.m.f.'s in the several machines on the circuit, under which condition the energy or load currents flowing in each machine will be of the same phase, and no wattless magnetising or

de-magnetising currents will circulate between the several machines.

In explanation of the general mode of operation of the apparatus, Fig. 1 may be referred to. AB represent the bus bars or line; CE, separately excited fields; D, field rheostat, hand control; F, phase regulator; GH, field members of regulator; IJ, polyphase windings; KH, current transformers; O, resistance coil; P, inductance coil; Q, contact arm; R, relay, plunger and coils; S, reversing switch; T, motor armature: U, field rheostat: Z, any source of excitation. The encircled windings 1, 2, and 3, represent single-phase, alternating-current generators, though the connections might also apply to synchronous motors, or any other synchronous alternating-current apparatus. It is also immaterial whether single-phase or polyphase machines are considered. Should any of the machines, say generator No. 2, have insufficient excitation, its current will be displaced in phase from the current flowing in generator No. 1, due to the lower terminal electro-motive force; this phase difference will cause the moving element and contact arm of the phase regulator connected between generators 1 and 2 to assume a certain position dependent upon the amount of phase displacement existing.

If the contacts *a* and *b* are so adjusted that at zero phase displacement the contact arm just swings clear of both contacts, then the above phase displacement and resulting position of the arm will close one or other of the contact points; one of the local relay circuits is thus energised, which, through the medium of relay coil, plunger, and reversing switch, starts into action the small motor operaing the field rheostat, connections being such that the direction of rotation will cut out resistance, thus strengthening the field of generator No. 2. A corrective force is thus applied to the existing phase displacement, which will be gradually diminished by the increasing field strength, until zero phase difference exists between generators 1 and 2.

When this condition obtains, however, the regulator arm will assume its former position —wherein the contact arm swings clear of either contact—breaking the relay circuit, which thus allows the motor switch to fly open, and hence stops further movement of the rheostat motor. The field of generator No. 2 is thus held at that value which tends to produce zero phase displacement with machine No. 1, for if the excitation of generator No. 2 has been unduly high, instead of low, as assumed above, a reverse series of operations would have been brought into play, resulting, however, in the same final approach to phase unity.

In similar manner, any other machines connected to the same circuit, be they generators, motors, or converters, may be held in proper phase relation with machine No. 1, which thus becomes the governing or "master machine" of the circuit; its field may be controlled by hand, or by an automatic means, which will tend to hold the desired station voltage. In stations where there are many units operating together, the above arrangement not only increases the

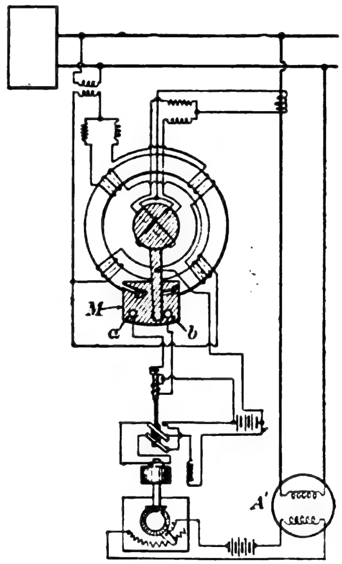


FIG. 2.

efficiency of the plant—through the suppression of the wattless magnetising or demagnetising currents circulating between machines, which result is now approximately obtained by hand adjustment—but it also eliminates the time and attention now required of the switchboard operator in securing the above adjustment.

A third application is for the automatic maintenance of a predetermined power factor between any machine and the circuit to which it is connected. This is one of the most important uses for the instrument, and applies more particularly to the field adjustment of rotary converters, synchronous motors or rotary condensers, the specific object being to automatically adjust the field

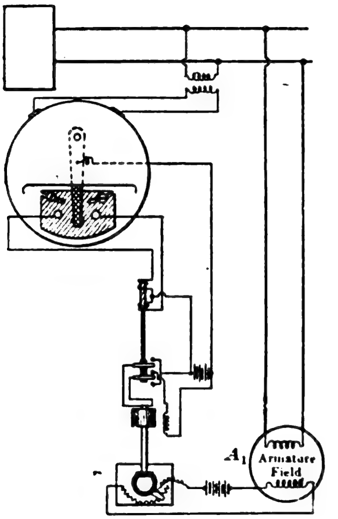


FIG. 3.

excitation of the one or several operating on the circuit, at such values as will maintain the power factor desired. To obtain this result only a slight modification of the arrangement shown in Fig. 1 is required; the actual connections, however, are set forth in Fig. 2 where A represents the armature and field circuits of the machine to be adjusted. In this application the phase difference between the wave of impressed e.m.f. and the current wave in any particular machine is the function to be controlled. Therefore, all the regulators on the circuit should have one of their magnetic elements, namely, the stationary element as shown on the drawing, excited by a current derived from the impressed electromotive force of the circuit, the windings on the other member of each regulator being energised by the particular machine to which the regulator is connected, and whose field strength it controls. With these conditions the relative position assumed by the contact arm in any regulator is obviously due to the phase difference between the impressed electromotive force and the current supplied to that particular regulator; or in other words is dependent upon the existing power factor.

By referring to the second application it will be seen that the operating conditions are such that the field strength and resulting phase displacement of any machine are automatically held at that value which causes the regulator contact arm to swing clear of either contact. Therefore, by adjusting the contacts viz., shifting them forward or back, various field strengths and corresponding phase displacements or power factors may be maintained. The movable insulating plate M (Fig. 2) carrying contacts *a* and *b* indicate one arrangement by which the desired adjustment may be obtained.

A fourth application is for the automatic maintenance of constant voltage. Merely the relay and operating mechanism previously described and retained, the selective device or phase indicator being replaced by a voltmeter mechanism, the movable arm of which performs the same service as rendered by the contact arm in the phase regulator closing one or other of the contact points *a* or *b* depending upon whether the voltage rises or falls below a predetermined value.

Fig. 3 shows the general diagram of connections. The machine A′, whose field is controlled, may be either a generator, rotary condenser, or other synchronous apparatus. In the latter event the voltage regulation is

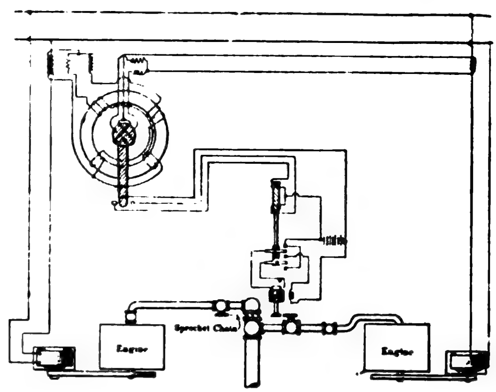


FIG. 4.

obviously obtained through the action of leading and lagging currents produced by over or under excitation.

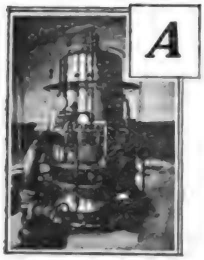
A fifth application is for the control of phase displacement due to speed variation. The general arrangement required is shown in Fig. 4, the essential difference from preceding figures being in the valves controlling the speeds of the engines driving generators whose displacement is to be regulated. Obviously, the same end may be obtained by making suitable connection between the motor and the speed governors which control the engines or prime movers.

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

Boiler Inspection.

By T. R. J. ORR, A.M.I.MECH.E.

[*In this article Mr. Orr reviews in detail the faults and troubles likely to arise in boiler room practice. We shall be pleased to publish matter on a similar subject from the pens of Engineers constantly meeting and solving the problems of boiler operation.*—ED.]



ALTHOUGH most boilers are insured nowadays, and consequently come under survey by the insurance companies' inspectors periodically, it is very necessary that the engineer in charge of a battery of boilers should from time to time go through them; therefore, he should know what faults to look for and how to find them. There are not many electrical undertakings which can keep a boiler-maker going, and it is not every engineer who has had the opportunity during his training of observing boilers under working conditions. He probably has seen boilers built whilst he was serving his apprenticeship, which is a very different thing to crawling through an old boiler and detecting weaknesses and faults. It is the purpose of this article to review some of the principal faults and weaknesses in boilers which have come under the writer's notice.

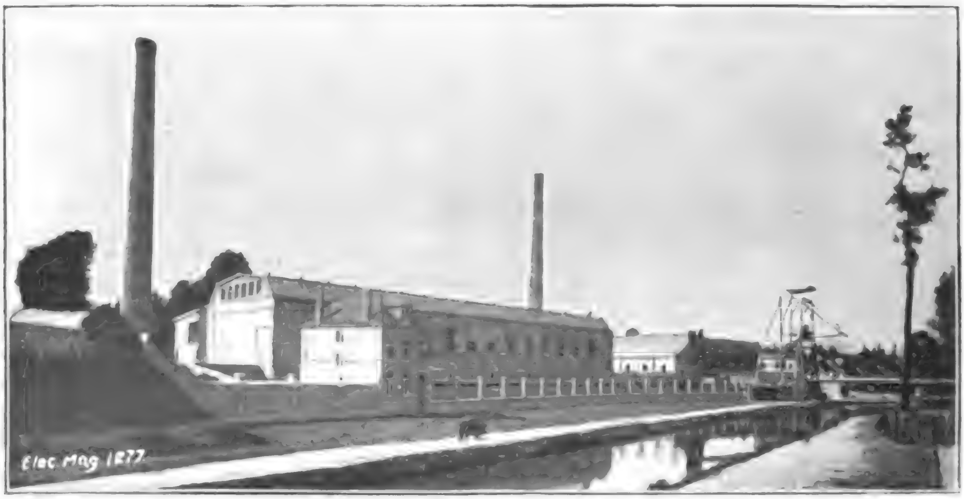
Lancashire Boilers.

Taking the Lancashire boiler first, one of its most common, and at the same time serious, troubles is grooving. This is nearly always due to lack of sufficient provision for the expansion of the furnaces. It does not occur so frequently in low pressure boilers as in high, and generally is to be found on the top of the furnace flues at the front end, although it will also start in other places along the furnace; but it is always near the root of an Adamson ring, and nearly always on top of the furnace. This is accounted for by the fact that the top of the furnace gets hotter than the bottom, and consequently expands more, and causes the flue to bend upwards. It is a pity that makers of this class of boiler do not provide more elasticity in the furnaces, either by putting in corrugated furnaces more generally than is done, or efficient expansion joints between the rings of the furnace flues. Grooving will sometimes take place directly under the gusset stays in the front plate, and sometimes at the back end plate; but as a rule it is to be met with on the top of the first ring of the furnace flues. The bottom rivets of the gusset stays in the front end plate are troublesome, again, owing to the "breathing" action of the furnaces. Some engineers are having these bottom rivets cut out and the holes plugged up. This is an easy solution of the grooving trouble, but it is open to severe criticism, as it exposes a very large area of unsupported flat surface on the front end plate to the full boiler pressure, as well as making it act as an expansion joint for the furnace. This is severe treatment to mete out to any flat plate, especially as the furnace flues in a Lancashire boiler 30ft. long will easily expand half an inch.

Corrosion Troubles.

Grooving takes place also at the circumferential angle of the front plate. Corrosion is to be looked for inside the boiler along the water level and along the line of firebars, where pitting sometimes takes place; right underneath the furnaces is another favourite place for corrosion, and this is generally caused

by air liberated from the water by the heat attacking the plates. The same cause often sets up corrosion where the feed water enters the boiler. At this point it may be well to warn engineers not to be misled by the delusion that there is a little scale on the plates. It is an exploded fallacy to suppose that a thin coating of scale will prevent corrosion, as it is often found going on merrily underneath the scale which is supposed to prevent it. Where chlorine is present in the feed water, or other corrosive gases and even air, corrosion will often take place in the steam space. A coating of white zinc and paraffin is useful in preventing this; further it does not burn off and lasts a long time. It is far better, however, to strike at the root of the trouble by driving off the corrosive gases and air. from the feed water by heating it before it enters the boiler at all.



Exterior View of Brussels Electricity Works, Auderlecht. showing coal-handling arrangements in the distance.
The Canal is the chief means of coal conveyance.

External Corrosion.

As regards the outside of the boiler, corrosion is the principal trouble to be looked for. The circumferential angle iron of the front end plate is often attacked directly over the blow down cock. If there happens to be a trench for the feed pipes where water can lodge and vaporise, this should be closely watched. Even without a trench it is a weak spot, as ashes are often slacked immediately on withdrawal from the ashpits and sometimes left lying in front of the boiler in a wet state; a more effective method of corroding the front plate and the angle iron could not well be imagined. Small leaks should never be allowed to go on from cocks and joints, especially if the drip is falling on the plates. The writer on one occasion put the ball end of a hammer right through a plate which was supposed to be $\frac{3}{8}$in. thick, but which was corroded to this extent merely by the drip from a leaky gauge glass cock. The boiler was of the vertical type, ten years old. Flue cover blocks and seating blocks should be removed occasionally if there is any suspicion of moisture getting between them and the boiler.

Inside the furnace flues blisters may be looked for on the furnace side of cross tubes and the joint at the back end plate and the flues is apt to start leaking and sometimes breaks the rivets. Look for corrosion between the side bars and the furnace flue: ashes will sometimes lodge here and get damp with the steam used by jets on mechanical stokers.

In boilers with lap riveted furnace flues, rivet hole fractures develop in the flues. Underneath the boiler in the flame beds rivet hole fractures may also be looked for. These fractures are often found where the flame impinges on the end of a riveted plate, and are no doubt due to metal fatigue.

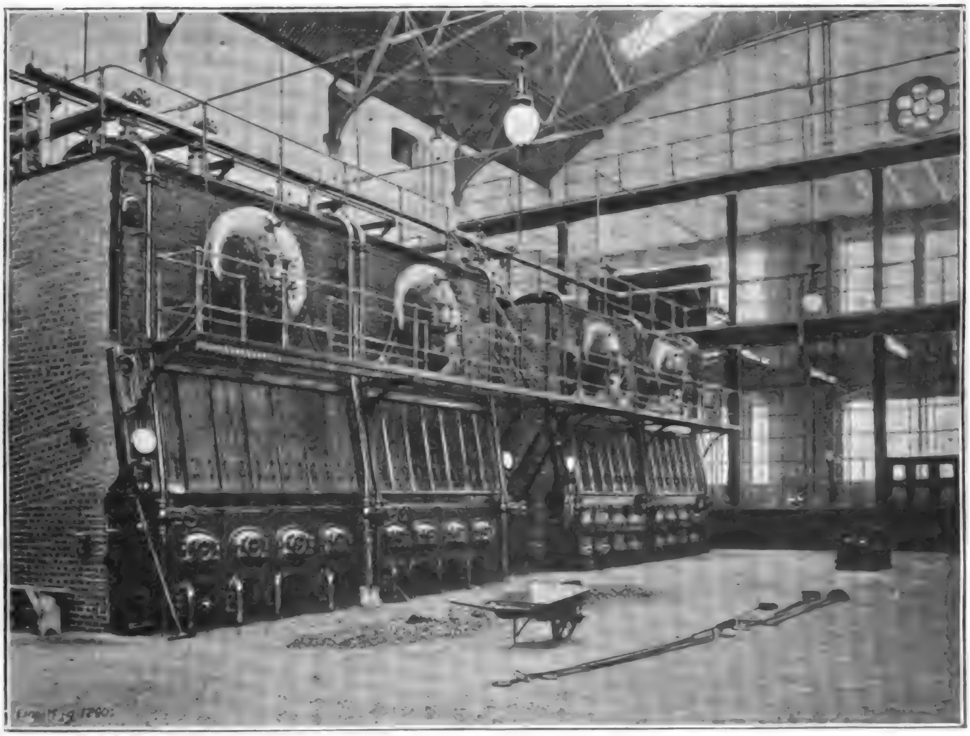
Marine Type Boilers.

In the Scotch or marine return tube type of boiler the stays in the steam space will often be found to be wasted away at the ends, particularly at the uptake end, the additional heat from the uptake probably having something to do with this. The end plates in the steam space will often corrode away, and this is the more serious as the corrosion is generally distributed and the rivet heads will retain their shape, although there is nothing but rust left. The air in the feed is responsible for this corrosion, and the best way to deal with the trouble is to keep air out of the boiler altogether. Superheaters are also attacked by the air in the steam. This corrosion acts in a very peculiar fashion, as in one boiler it will be very active in the steam space, whilst in another in the same battery it will be found going on elsewhere. No doubt the direction of the flow of the incoming feed water varies in different boilers and carries the air to different parts.

When the feed check valves are on the front of the boiler about the furnace level, attention should be given to the internal feed pipe to see that no joints are leaking and allowing the feed to escape below the tubes. In one instance which came under the writer's notice a furnace was so badly pitted through this cause that the furnace had to be patched ; the boiler was only three years old.

Pitting Troubles.

Pitting is not always due to air alone, but frequently to galvanic action, in which case zinc slabs suspended in different parts of the boiler are an effective remedy. The zinc slabs should be thoroughly cleaned every time the boiler is opened up to ensure them making good metallic contact with the point of suspension.



PORTION OF THE BOILER HOUSE, CHARLOTTENBURG ELECTRICITY WORKS.
Each boiler has 3,225 sq. ft. heating surface, and superheaters with 578 sq. ft. heating surface. Steam pressure is 150lb., and, as will be noticed, the boilers are hand-fired.

Combustion chamber stays will corrode away in the centre, particularly those underneath the combustion chamber. A good way to test the continuity of a suspected stay is to get a man to hold a hammer up against

one end of it and then to hit the stay a smart blow on the other end; if there is no rebound on the hammer the stay is certainly broken or corroded through.

Stay nuts in the combustion chamber give out at the weld under the influence of the high temperature, or will burn right away. They should always be renewed; the practice of riveting the stay over to save fitting a new nut is not sound, as the thickness of plate is calculated on the basis of a nutted stay.

Water Tube Boilers.

Babcock and Wilcox boilers can only be downwards—an engineer must use his discretion as to whether a tube which is bent or blistered should be cut out, and it goes without saying that because there is a slight blister or bulge, or that the tube is distorted slightly out of the straight line, it is not necessarily scrap.

It is of the utmost importance that the inside of each tube should be examined, either by passing a light down the tube or holding a lamp at the back end and looking down the front end. Any little accumulations of scale tending to stop the circulation will be easily seen by this method. These little

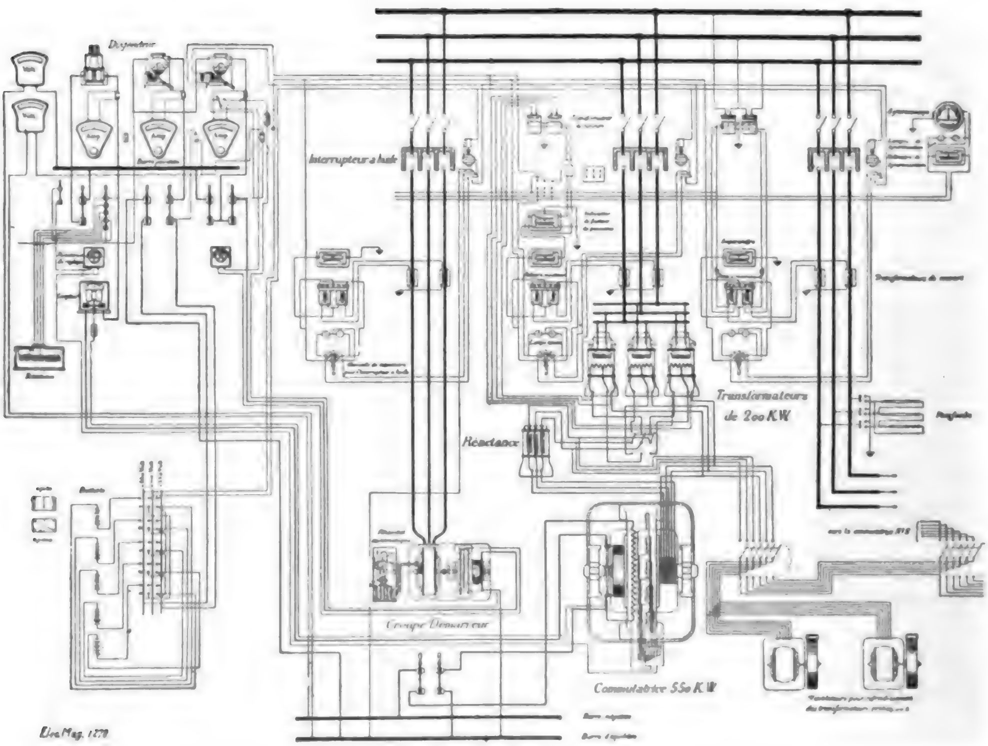


DIAGRAM OF CONNECTIONS OF MAIN SUB-STATION, BRUSSELS ELECTRICITY WORKS.
3-phase H.T. Feeders supply 350kw. rotary converters through 200kw. transformers of the air blast type. A separate motor generator set is provided for starting up from the direct current side.

surveyed in a partial manner, as it is practically impossible to examine a tube in the midst of a nest, but as tubes give out generally by merely blowing through a pin hole, it is not of much importance that it is impossible to examine the outside of each tube separately. The most important things to look for are blisters on the row of tubes nearest the fire and the second row up. The bottom tubes will sometimes bend

heaps of scale should never be permitted to exist, as they go on arresting other particles of scale until they form a dam in the tube and cause serious local overheating, and possibly blisters, and sometimes ripping of the tube. It is seldom, however, that we hear of a tube ripping, as nearly always a blister swells until it has drawn the metal at its summit out so very thin that it blows through in a very small hole, and gives

due warning of the existence of a faulty tube. Of course it is very important to keep oil out of a water-tube boiler, but no more so than it is to keep it out of any other type of boiler. If good water is in use there is really very little to look for in this class of boiler so far as the boiler proper is concerned. The brickwork, however, requires more attention than a Lancashire boiler. If bad water is in use charged with chemical impurities trouble must be expected and corrosion and pitting looked for both in the steam drum superheater and tubes, and with water rich in lime carbonates and sulphates scale will give trouble in the tubes.

When surveying a water-tube boiler it is very important to carefully examine the brickwork and iron doors for cracks and leaks, and to make certain that there is no stray way for air to get in to reduce the draught and impair the efficiency of the boiler. It is necessary to see before leaving the boiler that the mud drum blow down cocks are quite clear of scale or dirt. The small particles of scale accumulating in the mud drums will often completely block up the blow down cocks, and it is needless to point out how important this point is.

A Simple and Efficient Water Rheostat.

WE have frequently received enquiries as to an efficient and simple form of water rheostat and as considerable interest attaches to apparatus of this character we think the following taken from the *American Electrician* may serve to answer any future queries on the subject.

Many engineers know the little troubles connected with rigging up a temporary water rheostat for taking up a load while testing engines. Barrels and plates are usually employed, and a very usual weakness lies in the boiling of the water, and the consequent rapid fluctuation of the load, which always depreciates the engine performance. It is also generally necessary to use salt in the water, and too much of this will put the rheostat out of control. In Fig. 1 is given a diagram of a rheostat in which galvanised iron wire, immersed in pure water, is used. The one in question absorbed a load of 100 kilowatts for nine hours continuously, with less than 1 per cent. fluctuation, the final adjustment being obtained by controlling the inflow of circulating cold water, which simply overflowed the trough.

There were four coils used, which were all connected at one end to a copper rod. The other ends were each operated by switches so that approximately quarter, half, threequarters, and full load could be obtained at will. Two of the coils were of No. 14 B. and S. gauge, 180ft. long, and were made by winding on a 1¼in. arbor. The remaining two were made of No. 16 B. and S. gauge and were 150ft. long.

The receptacle in this case was a common horse drinking trough, and the coils were laid on a number of supporting cross-pieces.

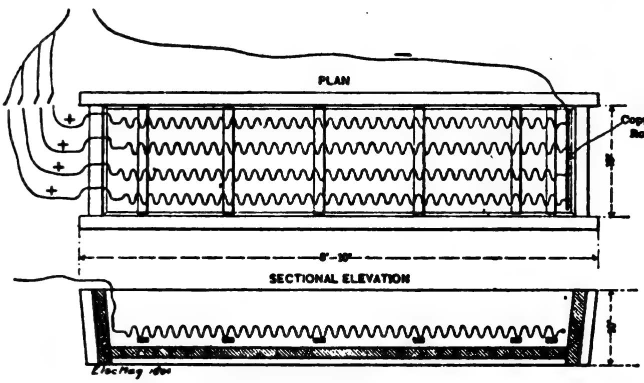


FIG. 1.—VIEWS OF A SIMPLE WATER RHEOSTAT

As there was a 3in. clearance between each coil there was no tendency to touch. Accompanying this is a table giving the data concerning the carrying capacity of iron wire under water.

CARRYING CAPACITY OF GALVANISED IRON WIRE IN WATER.

B. and S. Gauge.	Amperes.	Feet per 110 volts.	Feet per 550 volts.	Feet per pound.
20	36	25	—	309
19	42	27	—	293
18	50	29	—	232
17	60	30	—	164
16	71	32	—	146
15	88	34	—	107
14	103	36	—	91.9
13	122	38	—	72.1
12	145	40	200	57.8
11	173	42	210	45.8
10	205	45	225	36.4
9	245	47	235	33.3
8	293	58	290	25.0

Electric Refrigerating Outfits.

We are not yet afflicted in this country with such wide variations of temperature as are common to the climate of the United States of America, consequently we do not consume many thousands of gallons of "ice water," nor do we go in for refrigeration on a large scale. At the same time there are many hundreds of tradesmen in these little islands of ours to whom the use of ice at some period in the year is an absolute necessity. In these circumstances it is instructive to receive figures from a land in which refrigeration is an art, showing that electrically driven ice making plants of small output effect marked economies over the purchase of the ice from a local factory. To central station engineers this should be very good news, as motor operated refrigerators spell day load during the summer months when things are generally slack. The field for refrigerators was at one time limited to such purveyors of comestibles as butchers, grocers, and dairymen, but it has recently been much extended by the popularity of soda water fountains which hail from across the water.

Central electricity supply stations should take steps to cultivate the acquaintance of these desirable tradesmen, as they can be of immense service in helping up the day load, particularly during the warmer months. In their quest for orders they will be materially assisted by the following figures which we have taken from a paper presented before an American association of electricity supply concerns, and which are decidedly convincing.

In a drug store, or chemist's shop as we should know it, a large soda water business was done, with three fountains installed, but two only in use. Previous to the installation of the electric plant ice was delivered and unloaded once a day at the shop and much inconvenience was caused in breaking it up for use in the cooling apparatus. The temperature was also practically beyond control and could not be got below 40°-45°F. The figures for the cost of operating the three fountains under these conditions are given below:—

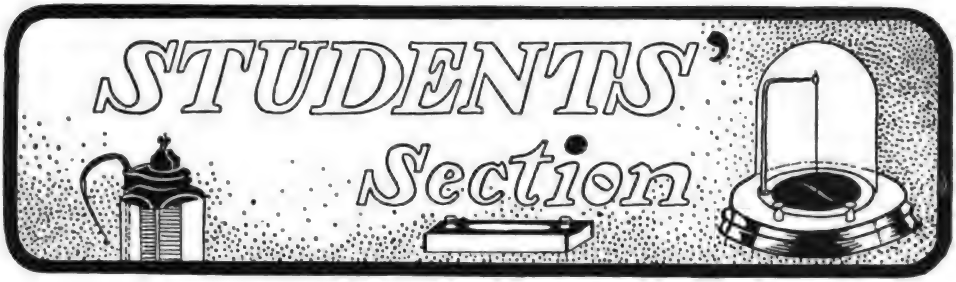
Ice consumption per annum ...	£164
Two men two hours per day for a year	50
Ice for cold water storage tank	93
Total for year	£307

On the recommendation of the Electricity Supply Company a 7½h.p. d.c. motor was put in to drive a three ton refrigerating machine, and the cost in this instance has been found to work out as follows:—

Power for one year	£116
Five per cent. interest on capital outlay (£420)	21
Condensing water	2
Depreciation and repairs 10 per cent	42
Oil waste, &c.	10
Total per year	£191

Saving by use of electric machine, £116.

It will be noticed that quite irrespective of the increased business which would certainly result, and of which no figures are given, that in less than four years the capital outlay would be recovered on the saving effected by the change. The margin in favour of the electrically-driven machine is, however, quite substantial enough to allow for errors in the figures, and for putting any other mechanical system quite out of court. Nothing is allowed for attention, as the plant requires practically none, and can be relied upon for constant satisfactory service. In a smaller installation furnishing 200lb. of ice per day, the cost of ice refrigeration was £38 per year, while for electrically-operated plant only £28 was needed, allowance for depreciation being made in each case. The necessary machinery in this case cost £70. The installation of these small plants depends largely on the price at which they can be obtained, and it is interesting to note that the supply company approached the makers in this case and persuaded them to market convenient sizes for the use of small tradesmen.



IMPORTANT.—Students should refer to our Editorial Columns this month, for a special announcement regarding this Section.

Memorising the Wire Table.

THE inter-relations of weight, resistance, length area and diameter of copper wire have for many years formed the subject matter of formulæ and tables, and in one or other of these they are recorded for practical reference. Pocket books and data are, however, never so handy as facts stored in the mind, and for this reason advantage should be taken of any means which permit of the easy memorising of rules constantly needing application. Students would do well to cultivate the habit of committing to memory certain fundamental rules and formulæ closely related to their practical work, as many references, wasteful both of time and energy, will thereby be avoided. The following example of what may be done in this direction will doubtless prompt students to cast about for similar means of dealing with other electrical rules and formulæ. We may say en passant that should any reader or student evolve something of this kind, we shall be pleased to consider its publication if submitted to us.

The particular instance of memorising a few fundamental relations of certain factors to each other which we have referred to above is connected with the B. and S. (Brown and Sharpe) copper wire gauge. The idea originates with Mr. C. F. Scott, of the Westinghouse Electric Co., and was published in the (then) *Electric Club Journal.*

RESISTANCE.— A wire which is three sizes larger than another wire has twice the weight and half the resistance.

A wire which is ten sizes larger than another wire has ten times the weight and one-tenth the resistance. As the resistance of No. 10 is 1 ohm per 1,000ft., the resistance of No. 0 is .1 of an ohm, and the resistance of No. 20 wire is 10 ohms. As the resistance of No. 4 is .25 of an ohm, the resistance of No. 14 is 2.5 ohms and of No. 24, 25 ohms.

In the following table the first column contains the sizes of wire which differ from one another by three sizes. The resistance of each wire in this column is seen to be twice that of the next larger size and one-half that of the next smaller size. There is therefore no difficulty in remembering this column. In the second division of the table the wires are ten sizes smaller than those in the first division: thus No. 11 corresponds to No. 1 and the resistance is ten times as great. In the third division of the table the wires are ten sizes larger than those in the first division; thus No. 0 corresponds with No. 10 and the resistance is one-tenth as great.

Size.	Ohms.	Size.	Ohms.	Size.	Ohms.
No. 1	.125	No. 11	1.25	—	—
,, 4	.25	,, 14	2.5	—	—
,, 7	.5	,, 17	5	No. 0000	.05
,, 10	1	,, 20	10	,, 0	.1
,, 13	2	,, 23	20	,, 3	.2
,, 16	4	,, 26	40	,, 6	.4
,, 19	8	,, 29	80	,, 9	.8
,, 22	16	,, 32	160	,, 12	1.6
,, 25	32	,, 35	320	,, 15	3.2

From this table several new relations may be observed.

If the wire is one size smaller the resistance is 25 per cent. greater. If the wire is two sizes smaller the resistance is 60 per cent. greater. If the wire is one size larger the resistance is 80 per cent. of that of the smaller wire. If the wire is two sizes larger the resistance is 63 per cent. of that of the smaller wire. From the foregoing the following are the ratios of resistance between wires of consecutive sizes:

.50, .63, .80, 1.00, 1.25, 1.60, 2.00.

WEIGHT.—The weight of a wire is inversely proportional to its resistance. Therefore, the foregoing relations are the same for weight as for resistance, excepting that the weights increase as the size of the wire increases, instead of diminishing. The weights of successive sizes of wire, therefore, bear the following relation, beginning with the smaller wire:

.50. .63. .80, 1.00, 1.25, 1.60, 2.00.

The weight of 1,000ft. of No. 10 copper wire is 31.4lb. Therefore, the weight of No. 7 wire is 62.8lb.; the weight of No. 0 wire is 314lb. The weight of No. 5 wire is 100lb. per 1000ft., which is a convenienient figure to remember. The weight of No. 2 wire is, therefore, 200lb., and the weight of No. 00 wire is 400lb.

AREA.—The area of No. 10 wire is approximately 10,000 circular mils (more precisely 10,380). The area is proportional to the weight. The area of No. 7. wire is, therefore, about 20,000 circular mils, of No. 0 wire 100,000, and of No. 0000 wire 200,000. The precise area of No. 10 wire is 10,380 circular mils. Taking this figure for easy calculation as 10,400 and following the process above indicated, the area of No. 0000 wire is found to be 208,000, which is very nearly 211,600, the figure in the wire table.

DIAMETER.—The diameter of No 10 wire is approximately 0.10in. (more precisely 0.102in.). The diameters follow the same ratio as the circular mils and weights except that this ratio applies to alternate sizes. Therefore the sixth smaller size has half the diameter and the twentieth smaller size has one-tenth the diameter.

SUMMARY.—The things to be remembered regarding B. and S. gauge copper wire are the following:

A wire which is three sizes larger than another wire has half the resistance, twice the weight, and twice the area. A wire which is ten sizes larger than another wire has one-tenth the resistance, ten times the weight, and ten times the area.

No. 10 wire is 0.10in. in diameter (more precisely 0.102); it has an area of 10,000 circular mils (more precisely 10,380); it has a resistance of 1 ohm per 1,000ft. at 20° Centigrade [68° Fahrenheit], and weighs 32lb. (more precisely 31.4lb.) per 1,000ft.

The weight of 1,000ft. of No. 5 wire is 100lb.

The relative values of resistance (for decreasing sizes) and of weight and area (for increasing sizes) for consecutive sizes are:

.50. .63, .80, 1.00, 1.25, 1.60, 2.00.

The relative values of the diameters of alternate sizes of wire are:

.50, .63, .80, 1.00, 1.25, 1.60, 2.00.

CIRCULAR MILS.—Conductors of large size are usually specified in circular mils. For example 500,000 circular mils, 750,000 circular mils.

As No. 10 wire has approximately 10,000 circular mils and a resistance of 1 ohm per 1,000ft., and as the length of a wire which has a given resistance is proportional to its area, it follows that the length in feet of a copper conductor having a resistance of 1 ohm may be found by dropping one cipher from the number expressing its circular mils; for example, No. 10 wire has 10,000 circular mils and a resistance of 1 ohm per 1,000ft., a 300,000 circular mil conductor has a resistance of 1 ohm per 30,000ft., and a 1,000,000 circular mil conductor has a resistance of 1 ohm per 100,000ft. The weight of a given length is proportional to the area; therefore, the weight of a conductor having 500,000 circular mils is greater than that of No. 10 wire in the same ratio that its area is greater. 500,000 circular mils is fifty times that of No. 10 wire or approximately fifty times 32lb, which equals 1,600lb. per 1,000ft. In this way the approximate characteristics of copper conductors of all sizes may be quickly ascertained.

To find resistance, drop one cipher from the number of circular mils; the result is the number of feet per ohm.

To find weight, drop four ciphers from the number of circular mils and multiply by the weight of No. 10 wire.

STUDENTS PLEASE NOTE.

We invite your co-operation in making this section more valuable to yourselves and others. Full particulars in Editorial Notes this month.

How to make an Electric Buckboard.

By J. C. BROCKSMITH.

(Continued from p. 250.)

FIG. 14 is a detail of the cap for closing the central openings in the cover plate. Two such caps are necessary, one having a hole in the centre for the armature shaft to pass through, while the one at the commutator end is left blank. Both these caps, as well as the cover plates proper, are intended to be cast of aluminum alloy containing 25 or 30 per cent. of zinc.

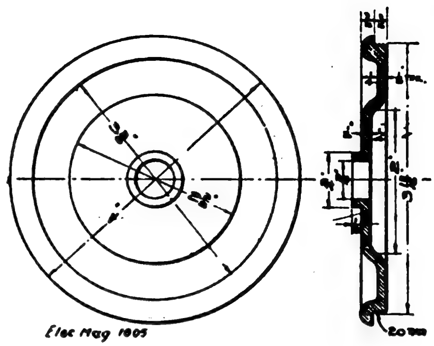


FIG. 14. DETAILS OF COVER PLATE CAP.

Fig. 15 shows the details of the armature and counter-shafts. The armature shaft can be conveniently made from a piece of $\frac{7}{8}$in. cold-rolled steel; if care is taken in centring the piece, the middle portion will not require turning. The shaft is drilled for pins to be driven in after the core discs have been slipped on and the cast end discs have been pressed into place.

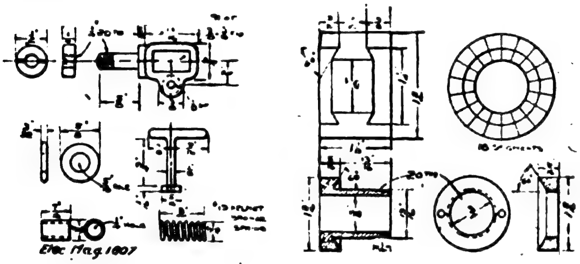


FIG. 16. DETAILS OF COMMUTATOR AND BRUSH HOLDER.

The counter-shaft is intended to be turned from a bar of 1in. annealed tool-steel, after which the cones are hardened. An easier but not so substantial construction is to use $\frac{1}{2}$in. cold-rolled steel with cones of tool-steel pressed on and pinned in place.

Fig. 16 contains the details of the commutator and brush holders. The commutator can be most conveniently made from a phosphorised copper casting turned to the size shown and then sawed into 18 equal segments by means of a No. 23 screw-slotting cutter mounted on a mandril in the lathe. The segments thus obtained are built up with mica insulation equal in thickness to that of the cutter, and are clamped in a brass sleeve and nut having flanges undercut at a 60in. angle. The brush holders are of cast brass; the slot for the brush can be cored very nearly to size and filed to a smooth finish. The brush should slide freely in its holder, but without play. The brushes should be of plumbago $\frac{3}{8} \times \frac{5}{8} \times 1$in., copper-plated, and each should "be pig-tailed" to its holder with some flexible bare copper wire. The springs are contained in a lug cast on the brush holder and are made up of No. 19 "Helmet" bronze wire, which is coiled on a mandril so as to be about $\frac{5}{16}$in. outside diameter. The insulation for the brush

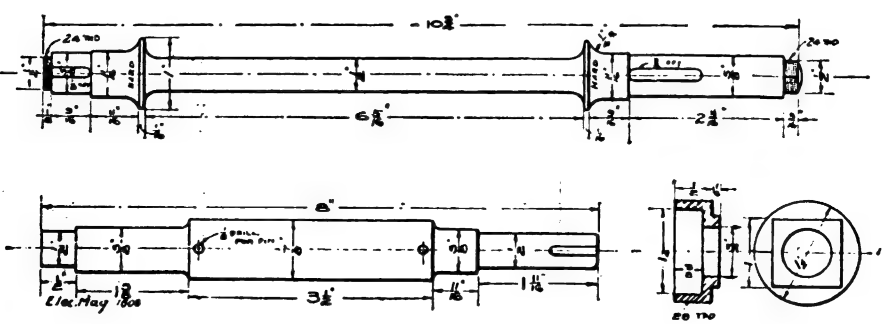


FIG. 15. DETAIL OF THE ARMATURE AND COUNTERSHAFTS.

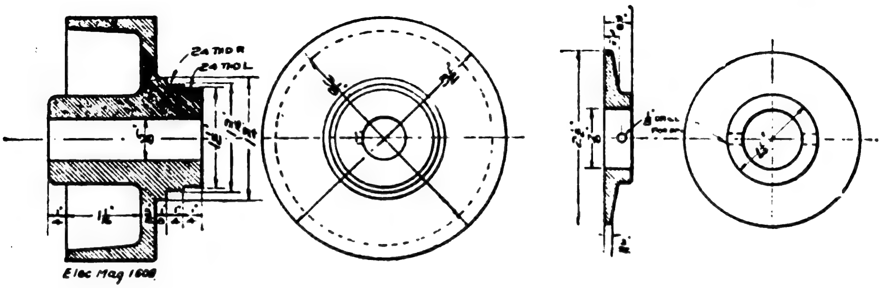


FIG. 17. DETAIL OF BRAKE DRUM AND END DISCS FOR ARMATURE CORE.

holders consists of fibre washers and some small fibre bushings, the dimensions of which are indicated in the drawing.

Fig. 17 shows the details of the brake drum and the end discs for the core. Both these parts can be cast of alzinc and are preferably finished all over.

Fig. 18 is a detail of the case for enclosing the motor reducing gears; this can be cast from alzinc and finished bright to give a good appearance. A half pattern will do, of course, as both halves of the case are alike. This case is intended to be partially filled with a heavy oil to reduce noise and wear of the gears to a minimum. The addition of some graphite in the oil also helps.

Fig. 19 represents graphically some results of a brake test of the complete motor, giving the curves of speed, torque and efficiency, as referred to amperes input. It will be noted that the efficiency is a maximum, 79 per cent., at 9 amperes input, this being almost exactly the usual full-speed current consumption when the motor is driving the buckboard. What the torque, speed and efficiency will be at any other current can be obtained directly from the curves, which makes it easy, by taking read-

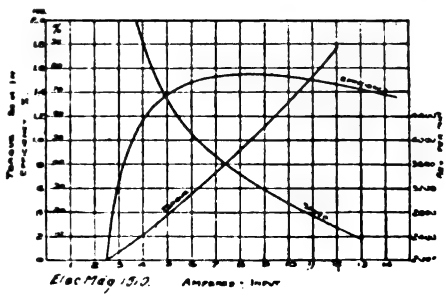


FIG. 19. BRAKE TEST CURVES OF MOTOR.

ings of current, to arrive at the resistance of various kinds of road surfaces and on hills. The speed of the motor at 40 volts, the second controller notch, would, of course, be half the value shown on the curve for the same current input. With a set of curves of this kind obtained from brake test and knowing the total ratio of reduction between armature shaft and rear axle it becomes unnecessary to take any speed readings on the road, as the whole performance can be deduced simply from the voltage and current readings.—*American Electrician.*

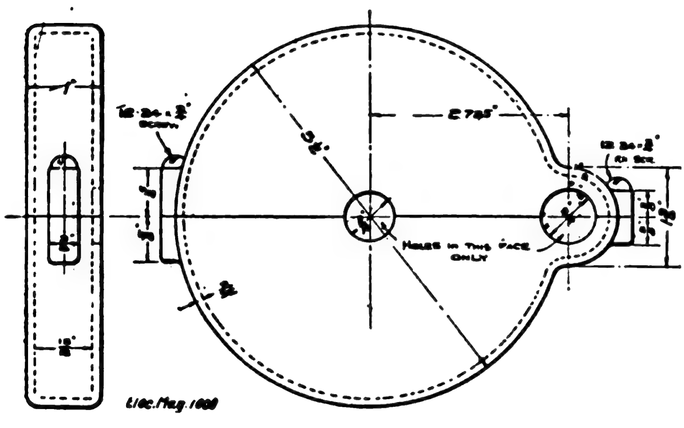


FIG 18. GEAR CASE FOR MOTOR REDUCING GEARS.

(*To be concluded.*)

Wiremen's Electric Light & Power Wiring Section

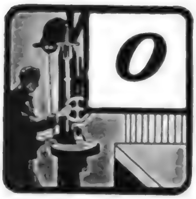
Artisans

Wiremen and Artisans should refer to the World's Electrical Literature Section for classified list of articles on subjects of importance to themselves.

The Installation and Wiring Connections of Generators for Direct and Alternating Currents.

By STUART A. CURZON.

(Continued from p. 540.)



OUR next feature is the *Compound-wound dynamo*, Fig. 13. This machine has the same advantages as the shunt-wound dynamo with the addition of the fact that the voltage will remain steady over a much wider range or variation of load. As will be seen by Fig. 13 each field magnet is wound with two separate coils, a few turns of thick wire carrying the main current in series with the armature being wound round the field, with many turns of fine wire which in shunt with the others are connected to the brushes only.

This machine is by far the best for all practical usages. There is yet another point that adds to its usefulness. It is sometimes found advisable where the actual place of consumption is situated some distance from the generator to increase the voltage at the dynamo when the load increases owing to the line drop. This can easily be obtained by over-compounding. As the current generated increases, so the series field current increases, thereby increasing the magnetism and raising the voltage.

It must be borne in mind that this machine cannot be used for charging accumulators unless the series coils are short circuited or cut out. Fig. 14 shows the simplest method of doing this. It often happens that with private house plant, where a battery is installed for all night load and the machine is kept running for direct lighting during the usual hours, that a compound machine is necessary, in which case the above should be carefully noted.

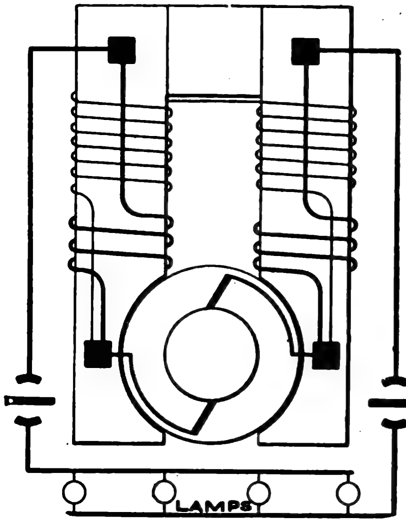


Fig. 13. Connections of Compound Dynamo.

Two compound wound generators are often required to run in parallel. In this case the series fields of both machines are connected in parallel. This is best done by means of an equaliser bar on the board. The wires should be so connected that each top brush has two distinct paths for current to flow, one through its own fields and the other through the fields of the other machine *via* the equaliser bar. Take particular care

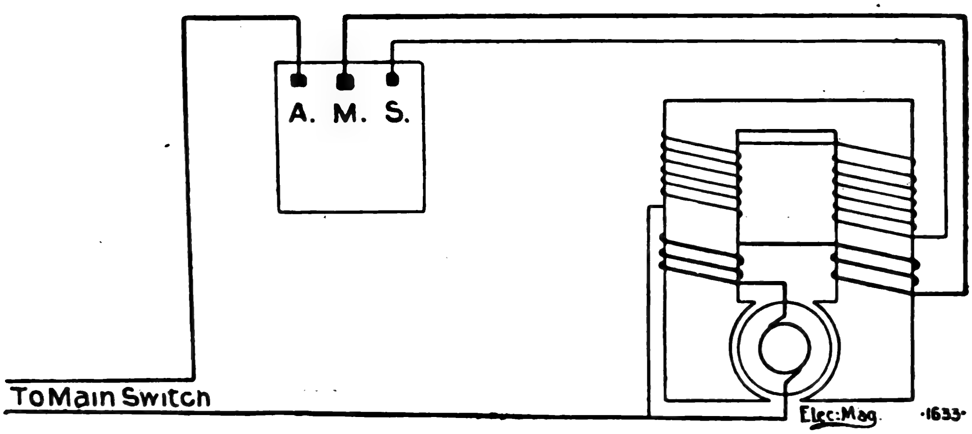


FIG. 14. METHOD OF CUTTING-OUT SERIES COIL COMPOUND DYNAMO.

in connecting up the ammeters, as, should they be connected on the wrong side, the reading will be out, as they will be influenced by the equaliser currents. An illustration of this will be given in our next issue. The equaliser switch must be closed at the same time as the others, or what is preferable, before them. This can be done best by using a triple throw switch on which one blade is made to close the circuit before the others.

The compound wound motor (Fig. 15) is

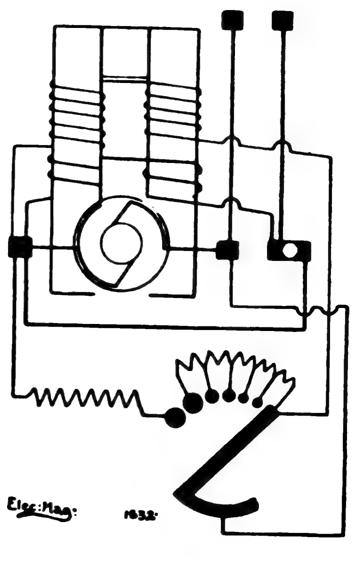


FIG. 15. CONNECTIONS OF COMPOUND WOUND MOTOR.

the nearest approach to perfection in this direction that we have. Where motors are used for driving machinery, &c., where heavy cuts are sometimes made and variable loads a frequent occurrence, say, for instance, with a shaping or planing machine, it will be found most advantageous to install a compound wound motor. There are two types of these machines—what are known as "cumulative" and "differential." Our illustration shows the former as the one most often used. In this instance, the shunt and series current flow in the same direction. In the case of "differential" winding the opposite is the case and wastage occurs owing to the fields opposing each other.

(*To be continued.*)

Notes.

WE have received a copy of "Practical Electric Wiring for Lighting Installations," by Charles C. Metcalf, A.M.I.E.E. (Harper and Brothers), which is a carefully thought work of instruction. That this should be so is to be expected, as among other appointments held by the author is that of Lecturer and Instructor in Practical Wiring at the Municipal School of Technology at Manchester. At present the question of the lack of ability shown by contractors, as demonstrated by the bad work that is in constant evidence, is a topic of constant discussion, and it would be as well if some of our plumber-gasfitter-electricians gave a few hours to the careful study of the book referred to.

While touching this question it would perhaps not be out of place to point out the fallacy of endeavouring to create competent electricians by means of the much-advertised schools of correspondence instruction. Not that we wish to disparage such institutions when properly conducted, but several instances have been brought to our notice of late which go to show that there are a good many fathers who think that a course of such instruction is sufficient to launch their sons on the waves of success in the electrical industry. This is, of course, absurd, and the numerous misleading advertisements always before us should be treated warily.

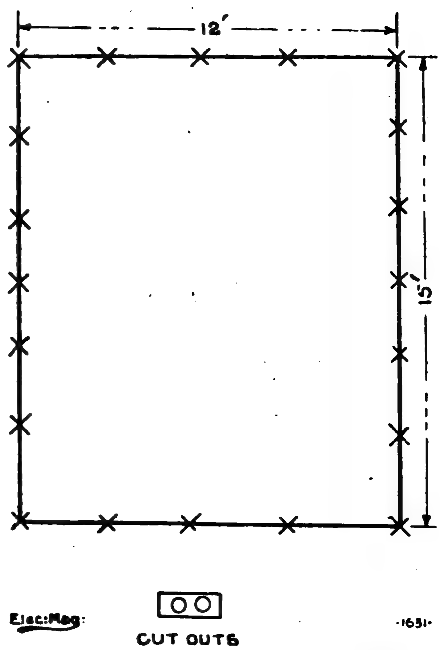
That a course of correspondence tuition may *assist* a young man in becoming proficient is likely enough, but the essential feature in the making of an electrician is to get one's coat off and "get at it." That there is plenty of room for the worker cannot be gainsaid. In the higher branches it is more doubtful, as is shown by the constantly recurring anomaly of assistant engineers receiving less in salary than their workmen take in wages. The hope of stepping to higher things is not always realised.

Trade is improving and wiremen, &c., are finding work more frequent. We were wanting a wireman last week and on ringing up the Union Secretary received the interesting information that there were no out-of-works on the books. This is certainly encouraging, and it is to be hoped that a continuance of full employment will be kept up.

The diagram given herewith is an interesting problem taken from the *American Electrician.* It shows a room 12ft. by 15ft. It has to be wired for 20 lamps. The voltage of supply is 220v. The lamps are to be 110v. The fuses are fixed 4ft. below the line of the lamps.

Which method of wiring will use the smallest amount of material when carried out?

On Saturday 3rd November the Hammersmith Borough Council's electricity department was the scene of a fatal accident whereby A. T. Boswell lost his life. While engaged on the H.T. distributor he received a shock of 2,500 volts. His death, which was witnessed by a number of his fellow mechanics, was instantaneous.



A Problem for Wiremen in the Economy of Material.
(See adjoining note.)

At the inquest it transpired that the deceased was instructed to remove an ammeter. This was fixed in what appears to be known as the danger zone, and according to the printed rules the deceased should have worked with rubber gloves and have stood on a rubber mat. The verdict was "Accidental Death," and was of course quite proper.

But is it not time that the fallacy of the india-rubber glove was quashed? Firstly it is almost impossible to handle small parts with such gloves. Secondly, and by far the most serious feature, is the sense of false security that the donning of gloves is likely to create in a workman's mind. It is quite possible to press or cut through rubber with, say, the sharp edge of a nut. Pinholes also develop and the moisture of the hand percolating through is sufficient to cause a big shock to the wearer.

Was it a matter of paramount importance that the ammeter should be moved from a live board? And is it not time that workmen should be forbidden to work on H.T. live boards except under the most pressing circumstances, when a responsible engineer, well alive to the risks to be run, should be compelled to personally attend and supervise what is being done.—S. A. C.

Questions and Answers.

GIVE a formula for determining the maximum current permissible for any size of tinned iron wire, when used in embedded electric heaters; also a formula for finding the length of wire for a given current and voltage.

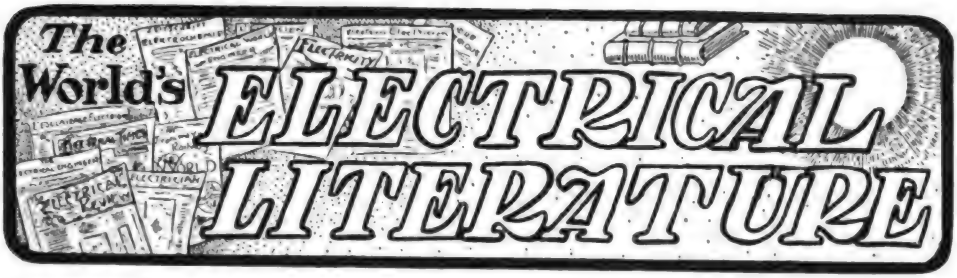
A.—The formula for the maximum current will vary greatly according to the substance used for embedding, thickness of substance, ratio of radiating surfaces to amount of energy used in heater, and several other items. If you are going to construct a heater, possibly the formula for the fusing point of iron wire will be of service:

$$d = \left(\frac{I}{a}\right)^{\frac{2}{3}}$$

where d is the diameter of the wire in inches; I is the current in amperes; and a is a constant, which for iron wire equals 3,148; of course a current sufficiently heavy to fuse the wire should not be used, but the value rather should be from one-quarter to one-half of this amount. For instance, if you wanted to construct a heater for ten amperes, at a potential of 110 volts, you would find from the above formula that ten amperes is sufficient to fuse an iron wire 0.0216in. in diameter. This wire has an area of approximately 466cm., and taking a size so that ten amperes would be one-quarter of the fusing current, we get an area of 1,864 circular mils, and the nearest size in wire to this is 18 (Trenton gauge), which contains 2,025 circular mils. The resistance of iron wire per mil foot is 58 ohms, at 0°C. The formula for arriving at the final temperature of the wire, and its final resistance, is rather complicated, but speaking roughly the final resistance may be taken as 174 ohms per mil foot. Therefore the final resistance per foot of the wire we have selected will be 0.086 ohm. As we wish to use a current of ten amperes, with a voltage of 110, the resistance of the circuit must be 11 ohms. Therefore approximately 123ft. of the wire will be needed.

(a) What governs the limit of excitation current over normal in synchronous motors? (b) What are effects on the synchronous motor when over or under-excited?

A.—Taking up question (b) first, we have the following condition: the motor runs in step with the supplying generator (except, of course, when the load becomes so great as to pull it out of step, at which point it will stop) and varying the field strength has no effect upon the speed. Assume that the machine is running, and then the field current can be adjusted so that the current taken by the armature is at a minimum. In this condition the power factor is 100. If now we strengthen the field, the current in the armature increases also, first slowly per step of the rheostat, and then with greater rapidity. The power factor drops down from 100, and the current in the armature *leads* the impressed voltage. If we lower the field current, the same effect is noticed, that is, the armature current increases, but with the field below the "normal" point the armature current *lags behind* the impressed voltage, and the power factor again falls below 100. In this way the motor can be made to draw full load current from the line, by over or under-exciting the field, and the machine can draw this full load current even though it be running idle. This same variation of current can be produced by changing the field strength when the motor is carrying a load; hence the advantage of using some synchronous motors where a large number of induction motors are also run—the synchronous machine can correct the lagging current produced by the induction motors, and the power factor in the transmission line can be made 100. (a) When a synchronous motor is running light or loaded with normal field, the iron losses remain practically constant, and therefore the heating from this source is also constant. As, by varying the field of excitation, the machine can be made to draw full load current and over, the copper losses, and consequent heating from this source, can be made to equal full load heating. As a matter of fact, the heating with full load current when the machine is carrying no load is really greater than if running under actual full load with the power factor at unity, because, under such conditions, the immense lag or lead requires a strong field excitation, and hence the heating from the field coils proper and the additional iron heating is greater. Therefore, the limiting feature of over or under-excitation is simply the heating of all parts of the machine.



You should carefully study this Section, as it will save you much valuable time. It is the key to the world's monthly Electric Progress.

Power.

Articles.

Electrical Equipment of the B. F. Sturtevant Co.'s Works. H. F. Knowlton.	*Elec. Wld. & Engr.* 30/9/05.
*Electric Operations about Massena.	*Elec. Wld. & Engr.* 7/10/05.
Electric Power on the Blackstone River, Mass.	*Elec. Wld. & Engr.* 14/10/05.
*Rise of Niagara Power.	*Elec. Wld. & Engr.* 14/10/05.
Recent Steam Turbine Installations on the Continent of Europe. F. Koester.	*Elec. Wld. & Eng.* 30/9/05.
The Largest Hydro-Electric Installation in Southern Asia. A. C. Hobble. (*See* "Power" this month.)	*Elec. Rev.*, N.Y. 28/10/05.
Cable Fire on High Bank at Niagara Falls. O. E. Dunlap.	*Western Electn.* 7/10/05.
Hydro-Electric Power Developments at York Haven, Pa.	*Western Electn.* 21/10/05.
Electric Power Developments at Massena.	*Western Electn.* 21/10/05.
Developments of the St. Croix Falls for Power Purposes. C. H. Coar.	*Western Electn.* 28/10/05.
New Power Station Equipment of the Boston Elevated Railway Co.	*Strt. Rly. Jrnl.* 4/11/05.
*Power Stations of the Electric Zone of the New York Central and Hudson River Railroad.	*Strt. Rly. Jrnl.* 11/11/05.
9,000 H.P. Steam Turbine for Brooklyn.	*Strt. Rly. Jrnl.* 11/11/05.
Electricity in American Mines. T. Campbell Futers.	*Elec. Rev.*, 6/10/05.
Colliery and Mining Switch Gear for H. and L.T.A.C. Service. A. M. Randolph.	*Elec. Rev.*, 10, 17/11/05.
The Transmission of Power by Alternating Current. A. Still.	*Elec.Eng.* 20/10/05.
The Distribution of Electricity in Mines.	*Elec. Eng.* 27/10/05.
Electricity in Sewage Disposal.	*Elec.Eng.* 17/11/05.

Papers.

Notes on A. C. Induction Motors. T. Harding Churton.	*Leeds I.E.E.* 25/10/05.
The Commercial Efficiency of Prime Movers. A. M. Downie.	*Glas. Tech. Coll., Scientific Soc.* 18/11/05.
Applications of Electricity in the Royal Gun Factory. H. C. L. Holden.	*Inst.E.E.* 23/11/05.
Electric Power-Plant Design. P. Ionides.	*Glas. Tech. Coll. Soc.* 4/11/05.
The Problem of the Gas Turbine. Dugald Clerk.	*Jnr. Inst. Engs.* 3/11/05.
The Influence of Electricity on Power Engineering. W. B. Essom.	*Civ. & Mech. Engs. Soc.* 5/10/05.
Inter-Urban Transmission. W. R. Pinckard.	*Ill.StateElec.Assn.* 5/10/05.
Constant Speed Motors and Centrifugal Pumps. C. P. Denman.	*Mich. Elec. Assn.* 10/10/05.
Some Experience with Lightning Protective Apparatus. J. C. Smith.	*A.I.E.E.* 27/10/05.
Notes on Lightning Arrestors on Italian Transmission Lines.	*A.I.E.E.* 27/10/05.
The Power House. F. N. Bushnell.	*Amer. Rly. Mech. and Elec. Assn.* 25/9/05.
Notes on the Design of Large Gas Engines with Special Reference to Railway Work. A. West.	*Amer. Strt. Rly. Assn.* 27/9/05.
Application of Gas Power to Electric Railway Work. J. R. Bibbins.	*Amer. Strt. Rly. Assn.* 27/9/05.
Performances of Lightning Arrestors on Transmission Lines. A. J. Neall.	*Amer. I. E. E.* 27/9/05.

Traction.

Articles.

*An Unprecedented Railway Situation. F. J. Sprague. (*See* "Traction" this month.)	*Strt. Rly. Jour.* 21/10/05.
*Speed Time Curves for Automobile Motors. F. B. Rae.	*Elec. Wld. & Engr.* 21/10/05.
*European Single-phase Railways.	*Elec. Wld. & Engr.* 21/10/05.
The Long Island Railroad System.	*Elec. Wld. & Engr.* 4/11/05.
Notes on Overhead Lines. H. V. Schreiber.	*Strt. Rly. Jour.* 4/11/05.
Hastings and District Electric Tramways.	*Light Rly.&Tram. Jour.* 3/11/05.
Bournemouth Corporation Tramways.	*Light Rly.&Tram. Jour.* 3/11/05.
Manchester Corporation Tramways Car Works.	*Light Rly.&Tram. Jour.* 3/11/05.
Belfast City Tramways.	*Tramwy. & Rly. Wld.* 12/10/05.
Overhead Construction. R. N. Tweedy.	*Elec.Rev.* 20/10/05.
Overhead Construction. A. Lineman.	*Elec.Rev.* 17/11/05.

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Power Distribution. L. P. Crecelius.	*Amer. Rly. Mech. and Elec. Assn.* 25/9/05.
The Single-phase Railway System. C. F. Scott.	*Amer. Strt. Rly. Assn.* 27/9/05.
*Ore Unloaders on the Docks of the Loraine Steel Co., Ohio.	*Elec. Rev.*, N.Y. 7/10/05.
Multiple Unit Systems of Train Control. K. Hazelton.	*Amer. Rly. Mech. and. Elec. Assn.* 28/10/05.
The Series Parallel Railway Controller. W. A. Pearson.	*Amer. Rly. Mech. and Elec. Assn.* 28/10/05.

Lighting and Heating.

Articles.

The Hoho Process of Heating and Working Metals by Electricity. P. Hoho.	*Elec.Wld.& Engr.* 30/9/05.
*Absorption of Light by Dust. V. R. Lansingh.	*Elec. Wld.& Engr.* 14/10/05.
Methods of Charging for Current Supply to Incandescent Lamps.	*Elec. Wld. & Eng.* 14/10/05.
Some New German Electric Projection Apparatus. C. J. Smith.	*Elec. Wld. & Engr.* 28/10/05
Modulating Electric Lamps. W. J. Phelps.	*Elec.Wld. & Engr.* 28/10/05.
*The Diffusing Reflector. E. L. Zalinski.	*Elec. Rev.*, N.Y. 4/11/05.
Electricity v. Gas for Public Lighting.	*Elec. Rev.*, N.Y. 6/10/05.
*Some Tests on Lamp Globes. M. Solomon.	*Electn.* 3/11/05.

Papers.

Do we need better Illuminating Engineering? J. R. Cravath.	*West. Soc. of Engs.* 13/10/05.
High Efficiency High Candle Power Incandescent Units. F. W. Willcox.	*Mich. Elec. Assn.* 10/10/05.
Electric Heating Devices. H. W. Hillman.	*Mich. Elec. Assn.* 10/10/05.
Electric Arc Lighting. F. Bailey.	*Olympia Exhibtn.* 17/10/05.
A Comparison Between Gas and Electricity in Regard to Their Use as an Illuminant. S. M. Hill.	*Northampton Inst. Eng. Soc.* 17/11/05.

Telegraphy and Telephony.

Articles.

Demonstration Apparatus for Wireless Telegraphy. A. F. Collins.	*Elec. Wld. & Engr.* 7/11/05.
*The Use of the Telephone in Army and Navy Manœuvres. B. K. Roberts.	*Elec. Wld. & Engr.* 4/11/05.
A Fire Alarm Telegraph Service in Greater New York.	*Elec. Rev.*, N.Y. 14/10/05.
*Earthed and Unearthed Radiators in Wireless Telegraphy.	*Electn.* 27/10/05.
Electric Signalling on the Great Northern and City Railway.	*Electn.* 27/10/05.
Telephone Extensions in Guernsey.	*Elec. Eng.* 27/10/05.
Modern Telephony, Theory and Practice. W. H. Radcliffe.	*Telephony.* Nov. /05.
Telephone Construction Practice. H. J. Minhinnick.	*Telephony.* Nov. /05.
Concerning Telephone Traffic. S. G. McMeen.	*Telephony.* Nov. /05.
Principles of Central Energy Systems. W. A. Taylor.	*Sound Waves.* Nov. /05.
Testing Methods in Telephony. P. K. Higgins.	*Sound Waves* Nov. /05.
Local Cabling. F. H. Nemitz.	*Sound Waves.* Nov. /05

Paper.

Telegraph and Telephone Progress. Presidential Address. J. Gavey.	*I.E.E.* 9/11/05.

Electric-Physics.

Articles.

Electrical Nature of Matter and Radioactivity. H. C. Jones.	*Elec. Rev.*, N.Y. 30/9/05.
Work of the Underwriters' Laboratories in Chicago.	*West. Electn.* 4/11/05.
*Possible Applications of Telemechanics. C. D. Kubiski.	*West Electn.* 4/11/05.

Papers.

The Measurements of High Frequency Current and Electric Waves. J. A. Fleming.	*Soc. of Arts.* 27/11/05
Dialetric Strength of Air. A. Russell.	*Phys. Soc.* 24/11/05.
On the Electrical Conductivity of Flames containing Salt Vapours for Rapidly Alternating Current. H. A. Wilson.	*Phys. Soc.* 24/11/05
The Theory of Phase Meters. W. E. Sumpner.	*Phys. Soc.* 27/10/05

Electro-Metallurgy.

Articles.

The Ruthenburg and the Acheson Furnaces. F. A. J. FitzGerald.	*Elec. Chem. Ind.* Nov./05.
The Application of Peat Fuel. L. A. Stillings.	*Elec. Chem. Ind.* Nov./05.

Papers.

Electric Furnaces. J. H. Stansbie.	*Birmingham Elec. Club.* 4/11/05.
The Metallic Preservation and Ornamentation of Iron and Steel. S. Cowper Coles.	*Soc. of Engrs.* 6/11/05.

Electro-Chemistry.

Articles.

Metallurgical Calculations. J. W. Richards.	*Elec. Chem. Ind.* Oct./05
Actions of Acid on Iron and the Use of Acid Pickle. C. F. Burgess.	*Elec. Chem. Ind* Oct./05.

Papers.

Some Problems in Electro and Electro-thermo Chemistry. R. Threlfall.	*Birmingham I.E.E.* 22/11/05.
*Alternate Current Electrolysis as Shown on Oscillograph Records. W. R. Hooper.	*Faraday Soc.* 13/10/05.

Students.

Articles.

Technical Classes. W. G. Rhodes.	*Elec. Rev.* 6/10/05.
Educational and Other Fads.	*Elec. Rev.* 20/10/05.

Papers.

The Training and Work of Engineers in some of their Wider Aspects. H. Dyer.	*Glas. Tech. Coll. Sci. Soc.* 21/10/05.

Design and Manufacture.

Articles.

Armature Re-action in Rotary Converters. C. F. Fechheimer and H. A. Berthold.	*Elec. Wld. & Eng.* 7/10/05.
Dynamo Iron Loss Increment on Full Load. A. Press.	*Elec. Wld. & Eng.* 7/10/05.
*Relation of Pull to Diameter Solenoids. C. R. Underhill.	*Elec. Wld. & Engr.* 7/10/05.
*The Design of Multiple Coil Windings. C. P. Underhill.	*Elec. Wld. & Engr.* 14/10/05.
A Proposed Phase Regulator and Its Applications. R. G. Watmough. jun. (*See* "Design and Manufacturing," this month.)	*Elec. Wld. & Engr.* 21/10/05.
The Cascade Converter.	*Elec. Wld. & Engr.* 21/10/05.
Dynamo Heating Time Constants. A. Press.	*Elec. Wld. & Engr.* 28/10/05.
The New Ferranti Switch-gear.	*Electn.* 20/10/05.
*Wave Shapes in Three-phase Transformers. R. C. Clincker.	*Electn.* 10/11/05.

Papers.

Air Gap Flux in Induction Motors. A. F. Langsdorf.	*Amer. I.E.E.* 22/9/05.
Standardization of Enclosed Fuses. H. O. Lacount.	*Amer. I.E.E.* 22/9/05.

Central Station Practice.

Articles.

*The Practical Operation of a Modern Railway Sub-Station. S. W. Ashe.	*West. Electn.* 30/9/05, 7/10/05.
Electricity Meters. C. H. W. Gerhardi.	*Electn.*, 27/10/05.

Papers.

Instructions to Men Operating Interconnected High and Low Tension Systems. W. F. Wells.	*Ass. Edis. Ill. Co.* 30/9/05.
Relation of the Central Station to the Motor Driven Refrigerator Machine. W. Goddard.	*Ass. Edis. Ill. Co.* 30/9/05.
Overhead *v.* Underground Central Station Circuits. H. B. Gear.	*Ill. State Elec. Assn.* 7/10/05.
Switch Gear. J. Whitchen.	*Rugby Eng. Soc.,* 19/10/05.
Theoretical Construction of Feeder Systems. W. G. Rhodes.	*Manchester I.E.E.* 28/11/05.
Street Cable Systems. S. J. Watson.	*Manchester I.E.E.* 28/11/05.
Practical Experiences with Steam Turbines. G. A. Radford.	*Ass. Edis. Ill. Co.* 12/9/05.
Starting up Large Inter-connected Systems Quickly after Partial or Total Shut-down.	*Ass. Edis. Ill. Co.* 12/9/05.
Relative Merits of Discharging Batteries on Edison Systems through Reversible Boosters and End Cell Switches. G. Goettling.	*Ass. Edis. Ill. Co.* 12/9/05.
Maintenance and Repair of Coal and Ash-handling Machinery. C. H. Parker.	*Ass. Edis. Ill. Co.* 12/9/05.
Relative Advantages of Twenty-five and Sixty Cycles. P. Torchio and C. L. Eglin.	*Ass. Edis. Ill. Co.* 12/9/05.

Wiremen.

Papers.

The Insulation of Cables and Wires Used by Electrical Contractors. C. J. Beaver.	*Elec. Contrs. Assn.* 24/10/05.
Zinc and Aluminium Fuses. A. Schwartz and H. N. James.	*Elec. Rev* 17/11/05

REVIEWS of BOOKS

"Monographien über Angewandte Elektrochemie: XVIII. Elektrolytische Verzinkung."

(Electro-deposition of Zinc.) By SHERARD COWPER-COLES. Translated by DR. EMIL ABEL.

"XIX. Die Elektrolytische Chlorat-industrie."

(The Electrolytic Chlorate Industry.) By J. B. C. KERSHAW. Translated by DR. MAX HUTH. Halle a/S.: W. Knapp. 1905. Prices M.2 and M.6 respectively.

The latest additions to the series of valuable monographs on applied electro-chemistry at present being issued by Messrs. Knapp, of Halle, consist of contributions from the pens of two well-known English experts.

Mr. Sherard Cowper-Coles, in a brief monograph extending over 37 pages, deals with the electro-deposition of zinc. The early part contains instructions for the proper treatment of the surfaces on which the deposition is to be effected, while the remainder is devoted to the arrangement of the electrolytic cell and to a consideration of the various factors which influence the nature of the deposit.

In an exhaustive monograph of 123 pages, Mr. J. B. C. Kershaw gives an account of the electrolytic processes employed for the preparation of chlorates. After a brief historical survey, the chemical and electrolytic changes involved in the producing of chlorates are dealt with, and then follows a descriptive account of the various processes actually in use on an industrial scale. The method of crystallisation, the properties and applications of chlorates, are dealt with in the next section. The important questions of efficiency and cost of production are then considered. A special section is devoted to the electrolytic preparation of perchlorates, bromates, and iodates, and another to methods of analysis. A very useful appendix contains a list of the more important patents and extracts from the patent specifications. This monograph will prove a valuable acquisition to all interested in the electrolytic production of chlorates.

"Physikalische Grundlagen der Gleich- und Wechselstromtechnik."

("Physical Foundations of Continuous and Alternating Current Technology.") By A. KÖNIGSWERTHER. M. Jänecke. Hannover, 1905. Price M. 2.60.

This little book of 120 pages is intended for students who are revising the theoretical portions of an electrical engineering course. It is essentially a compilation based on the standard German text-books on the subject. A knowledge of the differential and integral calculus is freely assumed. The book is divided into four sections, dealing respectively with electrostatics, the electric circuit, magnetism, electro-magnetism, current induction, and the alternating current circuit. A work of this description cannot, of course, lay claim to any originality, but will probably be found useful by the class of readers to whom it is specially addressed. There are, however, a number of blemishes which should be rectified in a future edition. In dealing with *resistance*, on p. 23, the author gives no scientific definition of this term, and the treatment of Ohm's law follows the bad old way, of which we are heartily sick, and which it appears impossible to eradicate from elementary text-books. The diagrams of lines of induction, on p. 46, are hopelessly wrong, no refraction of the lines being shown. And who, in the "Hausten and Kenelly," which occurs in the footnote to p. 109, would recognise the well-known names of Houston and Kennelly?

"Die Elektrolyse Geschmolzener Salze." Erster Teil.

("The Electrolysis of Fused Salts." Part I.) By R. LORENZ. Halle a/S: W. Knapp. 1905. Price M. 8.

The work under review forms vol. xx. of the now well-known series, "Monographien über angewandte Elektrochemie," and it is the first part of what promises to be an exceptionally comprehensive account of the electrolysis of fused salts. The preparation of the work must have involved an immense amount of trouble, and the reader interested in the subject will feel grateful to the author for so exhaustive an account of the work done by numerous experimenters in many lands, and for the bibliographical references which form a most valuable feature of the book. The general plan adopted by the author consists in taking each element in turn, and describing, as far as possible in chronological order, the various methods devised for preparing the element by the electrolysis of its fused salts. Constructional details are omitted, and no illustrations of actual apparatus are given, the author's main object being to give an account of general methods and principles rather than technical details. As a valuable work of reference the book is worthy of a place of honour in the library of every electro-chemist.

"Die Elektrochemie der Organischen Verbindungen."

("The Electro-chemistry of Organic Compounds.") By DR. WALTHER LÖB. Halle a/S: W. Knapp. 1905. Price M. 9.

This work forms, under a new title, the third revised and enlarged edition of the author's "Unsere Kenntnisse in der Elektrolyse und Elektrosynthese organischer Verbindungen (Our Knowledge of the Electrolysis and Electrosynthesis of Organic Compounds)." Owing to

the activity of numerous workers in this branch of science, considerable additions have been made to our knowledge since the publication of the second edition of the work just mentioned, and in the book before us the author aims at giving a general and up-to-date account of the part played by electrical methods in organic chemistry. The work is not intended to form a laboratory guide, and in the description of the various processes dealt with experimental details are omitted, only the leading features being considered. In accordance with the various methods by which electrical energy may be made instrumental in bringing about chemical reactions, the work is divided into two parts: Part I. deals with electrolytic processes, while Part II. is devoted to reactions which may be induced by sparks, arcs, and brush discharges. In each part the author first sketches the theory of the reactions, then gives a brief account of the experimental arrangements, and finally studies more in detail the various classes of reactions to which the methods under consideration may be applied. It may be noted that an English translation of the work is promised shortly.

"Entwurf von Schaltungen und Shaltapparaten."

(The design of switching systems and switchgear.) By R. EDLER. Vol. I. Hanover: M. Jänecke. 1905. Price M6.

Anyone who has ever attempted to design a system of connections to fulfil somewhat complicated conditions, or who has tackled conundrums connected with wiring problems, will readily understand how serious a loss of time the attempt at solving such problems may involve. There has, in fact, up to the present been nothing in the nature of a systematic treatment of diagrams of connections, and no attempt to utilise such diagrams for a perfectly straightforward and certain method of designing the necessary switchgear. The procedure has generally been a more or less haphazard one, and even when a solution of a given problem has with a great deal of effort and loss of valuable time been obtained, the solution has not necessarily been the simplest possible. It is, therefore, with great satisfaction that we welcome the first volume of a work by Prof. Edler on the subject of the systematic design of switchgear. The system developed by the author is both simple and certain. The reader need not infer that because two volumes are to be devoted to an exposition of the author's theory that theory is complicated. On the contrary the theory itself is, as we have already stated, extremely simple, its essential features being clearly outlined on some four pages. The bulk of the present small volume of 192 pages is devoted to numerous important practical applications of the theory to wiring problems relating to arc and incandescent lighting and the charging of secondary batteries under various conditions, and to controllers for cranes, automobiles, and electric railway and tramway motors. The author is to be congratulated on having rendered a real service to all electrical engineers who believe in scientific methods.

"Heinke's Handbuch der Elektrotechnik. II.: Die Messtechnik."

(Heinke's Handbook of Electrotechnology. Vol. II.: Measurements.) By C. HEINKE and J. KOLLERT. Leipzig: S. Hirzel, 1905. Price M.20.

The present instalment of the encyclopædic treatise on electrotechnology now being edited by Dr. Heinke contains the first part of the section devoted to measurements and testing. The contributors are the editor and Dr. J. Kollert. Dr. Heinke deals with general principles, with the electromagnetic system of units and standards of measurement, and with the classification, general features, and principles of electrical measuring instruments. Dr. Kollert, who contributes the remainder of the volume, gives a very full account of the measurement of current by voltametric and electromagnetic methods, the section dealing with galvanometers receiving extremely detailed treatment; the space, however, given to the description of more or less obsolete types of galvanometer wlll probably be considered excessive by most readers—especially as the work is not intended to be a historical one. The measurement of E.M.F. is next dealt with, and then follow sections on resistance measurements, the testing of conductors and insulators, the standardisation of instruments, the testing of primary and secondary cells, thermo-electric generators, continuous-current dynamos and lightning conductors, and the localisation of faults on networks. The last section contains a very full account of photometric methods, and a description of the more important standards of light and photometers. We should have liked to see a fuller account of the Flicker photometer than the meagre notice of it with which the author is content.

On page 31 we notice Lord Rayleigh's name twice misspelt "Raleigh."

Considered as a whole, the volume contains a large amount of useful and up-to-date information, and is worthy of the high ideal aimed at by the editor. The publishers deserve much credit for the beautiful "get-up" of the book.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

The Ferranti-Field Remote Control Switch.

THE development of the electrically-operated high capacity and high-voltage circuit-breaker has proceeded on more or less definite lines for the past five years. The early forms of high duty switches were generally placed in cellars and operated through systems of links and levers from the control gallery. The system of remote control was thus admitted and in its immediate developments pneumatic forms of circuit-breaker figured for a time Since then the field has been fairly evenly divided between motor and magnet-operated switches. Several forms of these have been put into very extensive use, and, although they have proved satisfactory in practice, their employment has accentuated the need for an even simpler device. The electro-magnet forms the ideal power agent with which to operate a switch, but the problem of its application in the simplest form, that is, without the intervention of chains, racks, or levers between it and the moving member of the switch, has not until recently been satisfactorily solved. The Ferranti-Field remote control switch described in what immediately follows seems to us to contain all the elements of an ideal high capacity circuit-breaker. The direct application of the pull of the magnet to the switch parts is a decided advance over anything hitherto accomplished with this form of circuit-breaker. The design of the magnet must commend itself for its extreme simplicity and efficacy to engineers aiming at the minimising of the working parts of all apparatus under their control. The switch controller itself also possesses many points of novelty, and it further embodies features which will make for the greater reliability of electrically-operated switch-gear. We think that Messrs. Ferranti, Ltd., must be complimented in having satisfactorily produced a switch which for its particular purpose embodies, as far as we can at present see, features giving the maximum of effect with a minimum of working parts. The name of the firm has been associated with the highest forms of switch-gear construction since quite the beginning of commercial electrical things, and it is quite fitting that at this time they should maintain their reputation for setting the fashion in heavy switch-gear design.

A good remote control switch should operate with absolute certainty and decision. It must not be possible to hold it in on short circuit, and if closed on a short or heavy overload it should at once open after the requisite time interval. Should the switch be still in the closed position the main switch under these conditions should not close a second time. When once the switch has been set to open or close it must be beyond the operator's power to check or reverse its motion until completed. The movement of the switch for the opening motion should not be entirely dependent on electric current. It should be possible to trip the release mechanically by hand from the control board in case of failure of the available supply sources.

Simplicity in the design of the mechanism is an important consideration, and all contacts essential to the operation of the switch should be located on a control panel and not on the switch itself. Small operating motors, magnetic clutches, and such like

devices are undesirable when forming the basis of the control mechanism. A simple solenoid, suitably constructed, constitutes an ideal arrangement in view of the absence of all complexity. The forces necessary for the operation of switches of this class are necessarily considerable, and it is desirable for this reason to avoid the interposition of levers between the solenoid plunger and the switch. With this end in view, Messrs. Ferranti have mounted the solenoid directly above the switch, and rigidly attached the moving portion of the latter to the solenoid plunger, the whole being guided in its vertical motion by suitable rollers and guides. This arrangement obviously necessitates that the stroke of the solenoid shall be equal to, or greater than, the required break of the switch, which condition calls for a very special design. To this end Messrs. Ferranti have divided their solenoid into two portions, an upper and a lower, each being provided with a separate plunger as shown in Fig. 2. The lower plunger is rigidly attached to the carriage C carrying the vertical steel tubes A which support at their lower ends the moving contacts. The upper plunger is concentric with, but not directly attached to, the rod R, which forms virtually a prolongation of the lower plunger. The upper end of the rod R is provided with a collar S which rests upon the top surface of the upper plunger when the switch is in the full open position. Thus, when the lower plunger is practically outside of its solenoid, the upper one is in a favourable position to be acted upon by the upper solenoid. Both upper and lower solenoids are energised together, the first half of the stroke being effected mainly by the upper plunger being drawn within its solenoid to its full extent, and carrying the switch mechanism with it, in virtue of the collar S. By the time the first half of the stroke is completed, the lower plunger has been brought into a favourable position to be acted upon by the lower solenoid, and the second half of the stroke is completed by the lower plunger, the rod A now passing freely through the upper plunger. By this device it is possible to obtain a very powerful long-pull electro-magnet, giving a stroke of 10in. with a minimum pull of 180lbs., and a maximum pull at the end of the stroke of 400lbs. The two springs S_1, S_1 are attached to the carriage C, and are so designed that in the closed position they are unextended, while in the open position they exert a lifting force of about 75 per cent. of the weight to be raised. The effect of these springs is two-fold. Firstly, they greatly accelerate the closing motion of the switch, and secondly, being unextended in the closed position, they do not retard the quickness of the break, but on the other hand take up the shock and jar

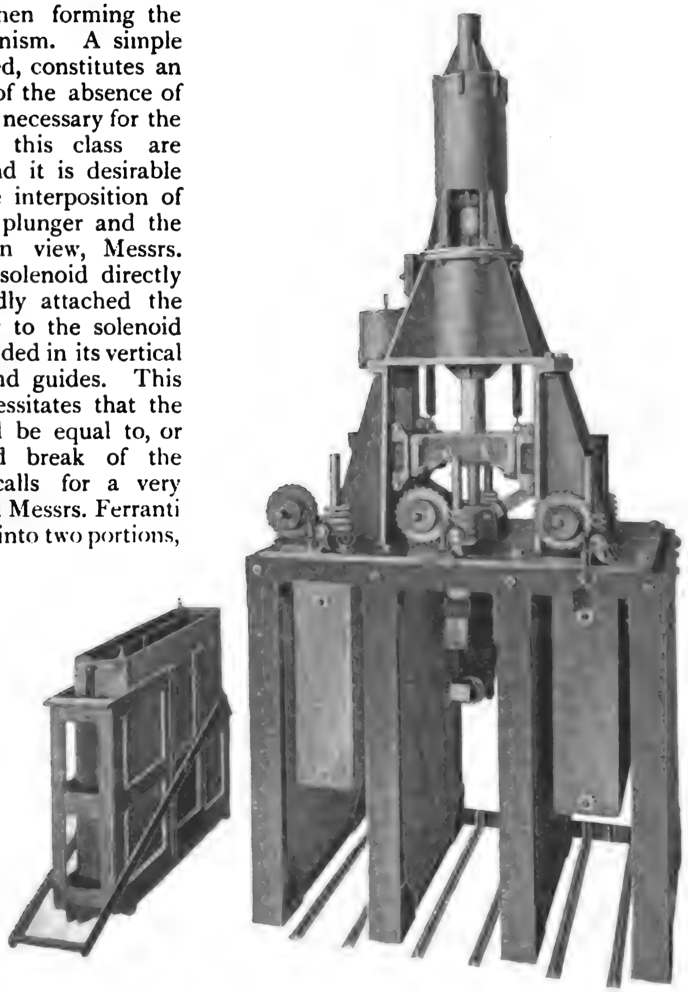


FIG. 1. VIEW OF COMPLETE REMOTE CONTROL SWITCH, WITH TANK LOWERED TO EXPOSE CONTACTS.

when the mechanism has reached the full open position. Further, two short and very stiff springs S_2, S_2 are introduced on the top side of the plungers. The effective force of solenoids increases very rapidly during the last portion of the stroke, and this is utilised in compressing these springs, the object of which is to aid the initial acceleration during the opening motion, and particularly at that instant when the friction of the main switch contacts has to be overcome.

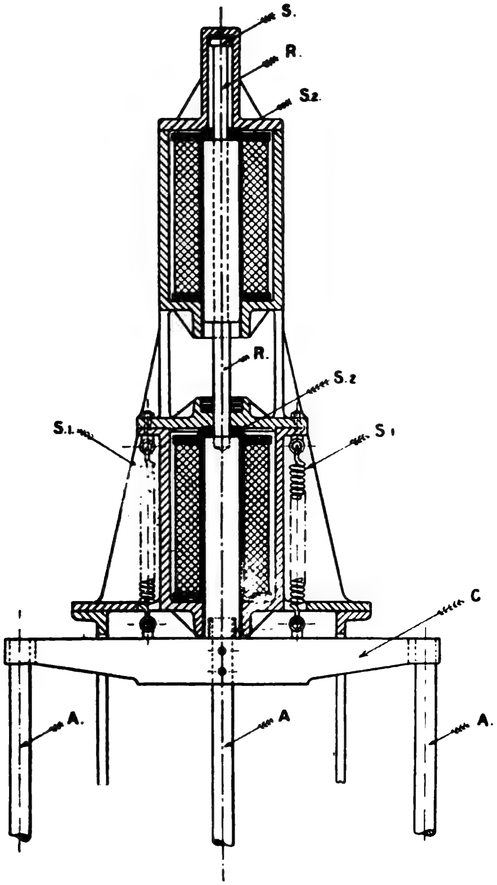


FIG. 2. SECTION THROUGH OPERATING SOLENOID.

The switch is held closed by means of the trigger and toggle arrangement depicted in Figs. 3 and 4. Eight links arranged diamond fashion are attached to the cast-iron top plate below and the moving carriage above, and a trigger M is pivoted on the right hand hinge pin and catches on the left hand hinge pin. The diamond pattern formed by the links opens out laterally when

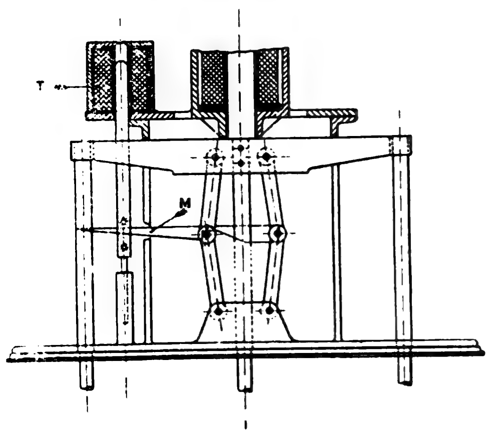


FIG. 3. RAISING AND LOWERING LINKS IN ON POSITION

the switch opens, the trigger, however, always remaining in a nearly horizontal position. When the switch is closed, the links are nearly vertical, forming with the trigger practically a toggle joint. It will be observed that this arrangement of links obviates all sideway thrusts against the frame, so that no undue pressure is brought to bear upon the guide rollers. The plunger of the trip coil T acts upon the end of the trigger M, a certain amount of free movement being provided so that the trigger M receives a hammer blow when the switch is tripped The switch can obviously be tripped by hand by raising the end of the trigger M. This can be arranged from the bench control board, and forms an alternative method of tripping the switch, which does not depend upon any electrical source.

Fig. 1 shows the main switch complete. Each phase is in a separate cubicle, there

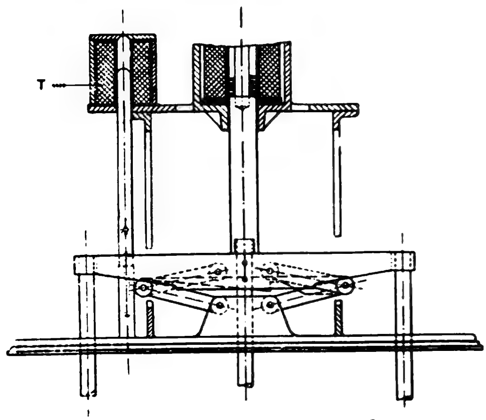


FIG. 4. RAISING AND LOWERING LINKS IN OFF POSITION.

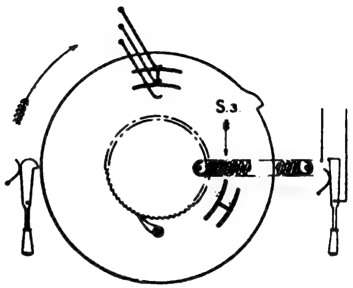


FIG. 5. CONTROLLER DRUM IN ON POSITION.

being two breaks per phase each 9in. in length, or a total interruption of 18in. per phase. The breaks occur, as usual, under oil within a carefully lined iron tank. Special provision has been made for an oil space between the tank and the insulating lining. This space is about ⅜in, and adds very materially to the effectiveness of the switch. When the circuit is broken under oil, the arc, which instantaneously forms, drives away the oil from the immediate neighbourhood of the contacts, thus considerably decreasing for the time being the dielectric resistance between each pole and the tank or earth. The layer of oil, however, between the tank lining and case is quite undisturbed, and this enormously increases the dielectric strength of the switch during the break. A special tank carrier is shown on the left hand side of Fig. 1. This runs into the complete cubicle on rollers, and permits of the tank being raised into position by means of the lever. This lever may also be attached to a wire rope and raised by the winding gear shown in Fig. 1, which enables a man single-handed to raise and secure a tank in position.

Figs. 5 and 6 show the front view of the controller, and represent its functions diagrammatically; for the sake of clearness the connections have been shown single pole—actually, they are double pole. Two positions are shown, the "off" position, and the position ready for synchronising or closing. The process of closing is as follows:—The handwheel, to which an ordinary controller drum is attached, is first turned through a little more than 180°, in which position it is arrested by a suitable catch. This motion has the sole object of extending the spring S_3, so that when the drum is released the revolution, half-made, will be completed. The drum is released by the closing lever on the left hand side, a small pressure on this being sufficient to release the catch which blocks the handwheel, after the first motion has been completed. On pressing the left hand lever the connection for energising the solenoid is made *instantaneously* by the drum passing under the controller fingers, and this connection is automatically maintained for a sufficient time interval to ensure of the switch completing its motion, and of the trigger engaging. This operation, of course, takes place in an extremely short space of time. By the time the handwheel has returned to its original position after completing one revolution the solenoid circuit has been interrupted and the switch is now ready for automatic tripping in the event of an overload. The switch may furthermore be tripped by the operator by pressing the right hand lever, the effect of which is to energise the trip coil. It will be observed that the special design of controller here described embodies several very material advantages. In the first place, the motion for closing the switch is a very simple and rapid one, the solenoids becoming instantaneously energised when this motion is made. Moreover, there is little fear of the switch being closed by depressing the closing lever inadvertently, since this will have no effect whatever unless the hand-wheel has first been turned through one half revolution; a suitable pointer is attached indicating whether this is the case or not. The controller is provided with a ratchet so that it can only move in

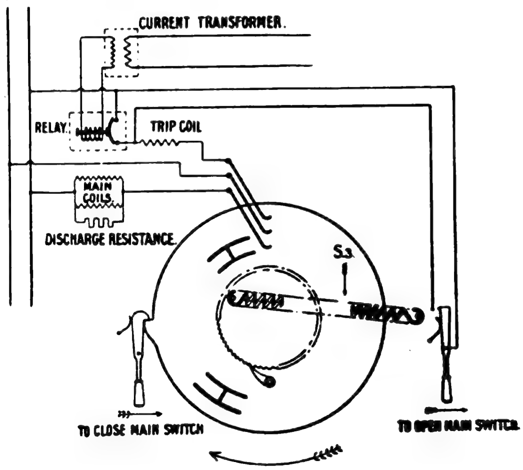


FIG. 6. CONTROLLER DRUM IN OFF POSITION, READY TO CLOSE SWITCH.

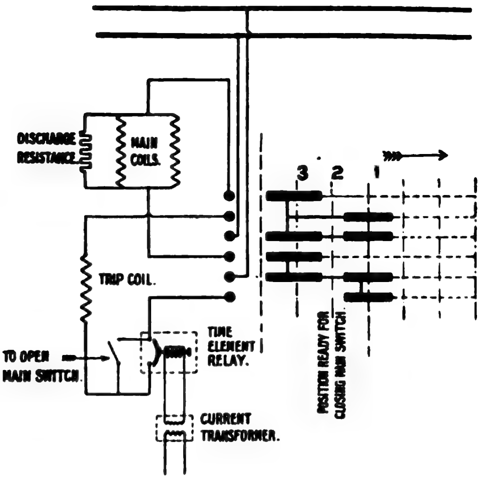


FIG. 7. DEVELOPED DIAGRAM OF SWITCH CONTROLLER.

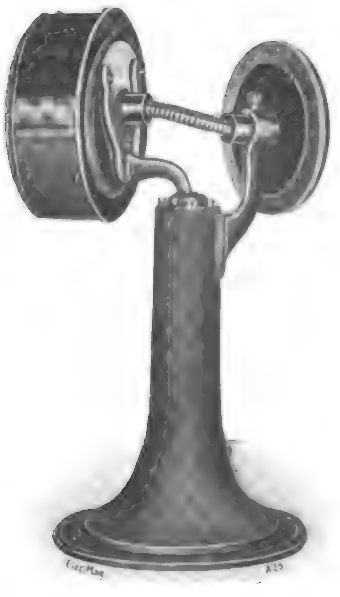
one position and cannot be turned back. A second ratchet is furthermore introduced between the hand-wheel and the drum, similar to the winding arrangement of a keyless watch, so that the drum itself cannot be arrested during the second portion of the revolution by the operator holding the hand-wheel stationary. It will thus be observed that, whereas the switch cannot be held closed on a short circuit, it is also impossible for it to close more than once, even though the closing lever be held in the "on" position; for in order for the switch to be closed a second time the handwheel requires to be set afresh. Signal lamps are provided on the operating panel, to indicate whether the switch is in a closed or open position, these being operated electrically by suitable contacts on the switch itself. Beyond these contacts, which are not by any means *essential* to the operation of the switch, no auxiliary contacts are to be found on the main switch. The design, by reason of its compact nature, admits of the best possible arrangement being made for leading cables both to and from the switch. This is an important matter, as fires are easily caused by constricted arrangements for wiring, and in fact are sometimes difficult to guard against. A further feature of the switch, to which we have not referred, is the hanging of the contacts from the switch base, and the placing of the tanks below them. All leakage of oil is at once guarded against by this expedient.

The Gratze Patent Speed Indicator and Revolution Indicator.

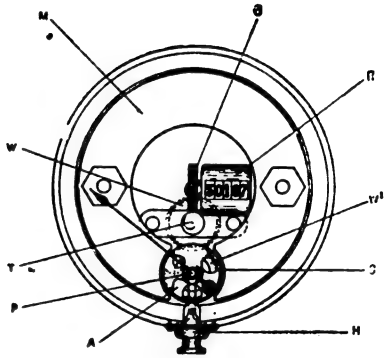
THE Gratze Patent Speed Indicator and Revolution Indicator, to which we referred last month, differs from any other speed indicator hitherto put on the market, in that the rotary mechanism of the instrument is entirely distinct and disconnected from the deflecting or indicating movement. The principle of action is decidedly novel; and its many distinct features distinguish it from other makes.

With indicators in which the action depends on centrifugal force, air vanes, or complicated mechanism, the wear and tear are very considerable owing to the high rate of speed at which the mechanism rotates; this naturally results in a very short life for the instrument. In addition the rotary mechanism must attain a fairly high speed before the movement commences to indicate. Again there is always a certain amount of friction which tends to cause errors in the reading. The Gratze Speed Indicator and Revolution Indicator obviates these drawbacks, and numerous other advantages are claimed for it.

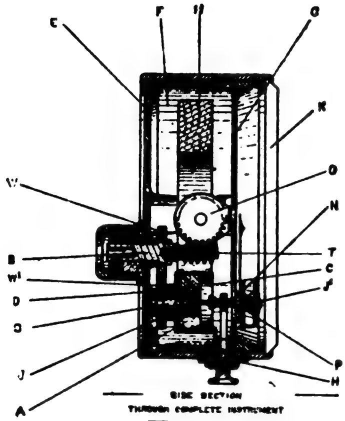
We may mention that it is of British workmanship throughout and is manufactured



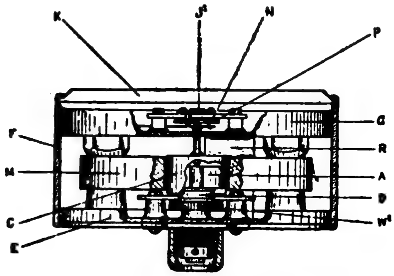
SIDE VIEW OF SPEED INDICATOR, SHOWING SWIVEL AND PULLEY.



PLAN OF INTERNAL MECHANISM, DIAL REMOVED.



SIDE SECTION THROUGH COMPLETE INSTRUMENT



HORIZONTAL VIEW OF MECHANISM, WITH PART OF COVER, DIAL, MAGNET, BASE & MOVEMENT CUT AWAY.

TABLE OF REFERENCE LETTERS FOR THE PARTS OF THE GRATZE PATENT SPEED INDICATOR.

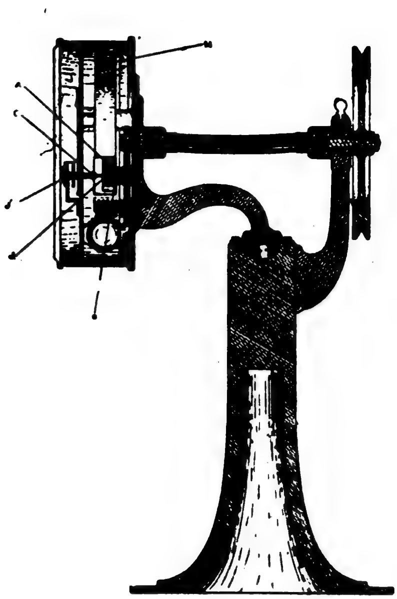
M, Magnet.	W, Spindle Spur Wheel.
A, Armature.	W', Armature Spur Wheel.
S, Steel Spindle.	D, Gun-metal Collar.
J, Bottom Jewel.	R, Recorder.
J', Top Jewel.	N, Spring.
P, Movement.	O, Recorder Wheel.
C, Copper Cup.	T, Worm.
B, Adapting Spindle.	E, Base.
F, Cover.	G, Dial
H, Pointer Clamp.	
K, Glass.	

in lots of 100 to 200, so that separate parts can be made interchangeable. The method of calibrating ensures absolute accuracy in the reading of the instrument, which, further, is quite dead beat under all conditions of vibration. As the deflecting movement is quite distinct and separate from the rotary portion, over-running or reversing has no detrimental effect on the instrument. Breakdowns through wear and tear of friction wheels are obviated by the use of a positive drive and connection, which transmits the rotary motive through a flexible steel shaft to the instrument.

The revolution indicators can be supplied with scales for any range up to 10,000 revolutions per minute.

Having roughly reviewed the practical points of the indicator, we may now refer to the principles of its action and mechanical construction.

Referring to the illustrations : M is a permanent magnet, the permanency of which is assured by a special ageing process. Placed centrally between the poles of this magnet is the three-pole iron armature, A, which revolves round a steel spindle, S; in this latter is set the bottom jewel, J. The movement, P, to which is fixed the copper cup, O, and pointer, is attached and balanced accurately on a fine steel pivot, the extreme points of which rest between the jewels, J and J. This, it will clearly be seen, allows the copper cup, O, to turn freely in the gaps left between the two magnet poles and the cages of the three-pole armature, A. The adapting spindle, B, is connected to the flexible shafting, and when in action rotates in a counter clockwise direction (when looking on the face of the instrument), it transmits its motion to the small spur wheel, W', through the medium of the spur wheel W. It will be seen from the sketch that W is fixed to the adapting spindle B, and that W' is fixed to the armature A by a gun-metal collar, D, and, consequently, the armature revolves in a clockwise direction. When



SECTION THROUGH COMPLETE INSTRUMENT.

the armature begins to revolve, it induces the lines of force from the magnet through the copper cup in the form of an unequal field creating eddy currents in the copper.

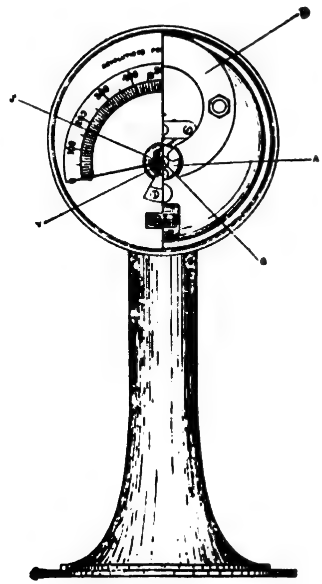
The strength of these currents increases with the speed of the armature, which exerts a pull or drag on the copper cup, and a very few revolutions per minute would suffice to cause the whole movement (which, as explained previously, is pivoted between two sapphire jewels to ensure a minimum of friction) to revolve at a proportional speed—therefore this pull or drag is controlled by the spring, N. This naturally limits the deflection, which now becomes proportional to the speed of the armature; therefore, as the speed of the latter increases, so the deflection of the pointer increases also, and this is calibrated off on a scale in miles per hour, revolutions per minute, or any indicated quantity required.

The Recorder, R, is driven by a worm, T, through the medium of a variable toothed wheel, O. The worm, B, is attached to the adapting spindle and spur wheel, and naturally turns at the same speed as the spindle; or, in other words, at a proportional speed to the rotary medium to which the instrument is attached. By altering the ratio between the wheel, O, and driving worm, B, it is possible to record the distance covered, or revolutions made by any size wheel, etc., also by varying the control of the spring it is possible to limit the deflection to such an extent that the maximum indication of speed would be about 120 miles per hour; or, on the other hand, it is possible to lessen this control so much that the movement would be sensitive enough to indicate a maximum of five miles per hour.

It will be seen that the movement will indicate the slightest variation of speed, but, at the same time, it will not be affected in the least by the vibration or jolting of the car or machine to which it is attached; also will be seen the benefit of having an indicator that is absolutely free from any likely damage, due to reversing the car or engine, or to attaining a much higher speed than that indicated on the dial.

The whole mechanism is mounted on a gun-metal base, E, and contained in a solid brass case or cover, F. The dial, G, covering the mechanism is dull silvered, the scale engraved thereon and then filled in with black wax.

The pointer clamp, H, is a simple mechanical contrivance which grips the stem of the indicating movement when the button is pressed, and releases same when it is pulled, thus allowing the pointer to immediately fly back to zero.



FRONT VIEW HALF OF CAP AND FACE REMOVED.

Gratze Revolution Indicator, Front View.

The instrument has been made to meet a long-felt want. It is light and portable. It can be used in many ways: For instance, it can be driven from a fly-wheel or shaft by a pulley and belting, or be directly coupled by the flexible shafting to the engine ; again, by placing a rubber ring in the groove of the pulley on the instrument and holding it against the fly-wheel, a third method of ascertaining speed is obtained.

It is very useful in a turning shop for ascertaining the speed of any revolving material or metals required to be turned in lathes. The pulley of this instrument, being approximately 4in. in diameter, when driven by a belt will give the revolutions per minute. On the other hand, a rubber ring can be placed in the groove, and if held against any revolving material, will give the surface speed in feet per minute, and act as a surface cut meter.

New Catalogues

Electrical Novelties.—F. Darton and Company, Clerkenwell Optical Works, St. John Street, E.C. The approach of Christmas will probably turn the thoughts of parents to a suitable present for their electrically-inclined youths. The new catalogue of Messrs. Darton and Company should considerably assist the selection of something suitable in the way of small motors, dynamos, instruments, batteries, lilliputian gas engines, telephones, and shocking coils. There is a very wide range in that way to select from, and as the apparatus is of British manufacture the quality and finish may be relied on. A speciality is made of the parts of most of the standard articles so that any enterprising youngster can be entrusted with the task of building up his own machine.

Annealing Furnaces.—The Bates and Peard Patent Annealing Furnace Company, Huyton, Liverpool. We have already referred in our August issue to this very interesting process of annealing non-ferrous metals, and we now have received a handsome pamphlet giving a quantity of further interesting details. Our own article from the August number forms the introduction. The remainder of the pamphlet contains descriptions of different types of furnaces with notes on the special features of their application. The smallest size is a jeweller's furnace, for such articles as studs, sleeve links, chains, watch cases, &c., and the largest, a furnace for handling copper wire having a capacity of 100 tons per working day of twenty four hours. Every manufacturer who is interested in the annealing of non-ferrous metals should obtain a a copy of this highly valuable booklet without delay.

Pelton Wheels.—Carrick and Ritchie, Water-power Engineers, Edinburgh. There is evidently still ample room for water-power motors in the industrial field, judging by the scope of work of this character covered by a new catalogue of this company. Mixed flow, impulse and Pelton wheel types are constructed for various sizes, and a standard line of these is exploited for direct coupling to dynamo electric machines.

Time Recorders.—Messrs. Howard Bros., Patentees and Makers of the "Dey" Time Register, ask us to refer to the inventions of Mr. F. Muncaster Howard in connection with their instruments. They comprise an automatic device by which the type carriage is propelled automatically from one column to another (*i.e.*, "morning in," "breakfast out" and so on), at pre-arranged times, working for a whole week without attention ; and a device for bringing into use a duplex coloured ribbon (red and black), for printing the time of "punctuals" in black and "late" comers in red ink, thus the "lates" are quickly distinguishable from those "up to time," &c. This duplex ribbon device is at present manipulated by hand, but Mr. F. Muncaster Howard has invented various ways of working this automatically (mechanically and electrically) and will have complete working specimens on the market shortly.

The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

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The World's Electric Progress.

Greetings.

WE take this opportunity of extending to our many readers, both at home and abroad, hearty greetings for the festive season and good wishes for the coming year. We also make this the occasion of announcing that our programme for the New Year will materially improve the arrangement of the magazine and greatly enlarge its field of utility. We shall further develop the various sections on the lines of an electrical Review of Reviews so that readers may be assured every month of obtaining a *multum in parvo* of electrical information within the columns of the paper. There is so much valuable and instructive matter contained in the many important articles contributed to the World's Electrical Press that electricians will welcome a journal in which they can be certain to find a concise epitome of the best that these articles contain. The existence of several important reviews which deal concisely with the contents of the world's lay literature justifies our contention for the indispensability of a similar record of the technical electrical Press. We are convinced that on slightly remodelled lines the sections of this journal will furnish a monthly record of electrical events and progress of certainly greater value than it has hitherto proved. In closing our fourth volume we invite, as we have previously done, suggestions from our readers as to the conduct of the magazine, as it frequently happens that they are in a better position to make these than we are ourselves. Our January issue will be of a special character, as it will celebrate our second birthday. We shall make it an accurate review of electrical events during the year past, introducing at the same time a number of the new features outlined above.

To Our Students.

WE announced fully last month the new programme which, with the assistance of students, it is our intention to carry out during the coming year in that particular section. We think it may be well to again remind our student readers that this proposal directly affects their interests, and would, we think, be of great aid to them in the discussion of important electrical subjects. The section will, we hope, become a kind of debating society, with this difference, that the subjects discussed will be put into print and will remain a permanent record of the work accomplished. The Students' Sections of the Institution do not always afford a sufficient outlet for budding aspirants to literary honours, nor is the publicity secured anything like the same as that obtainable in the columns of an electrical journal. We shall welcome any suggestions from our student readers regarding this scheme, and trust that they will heartily take it up and make it a complete success.

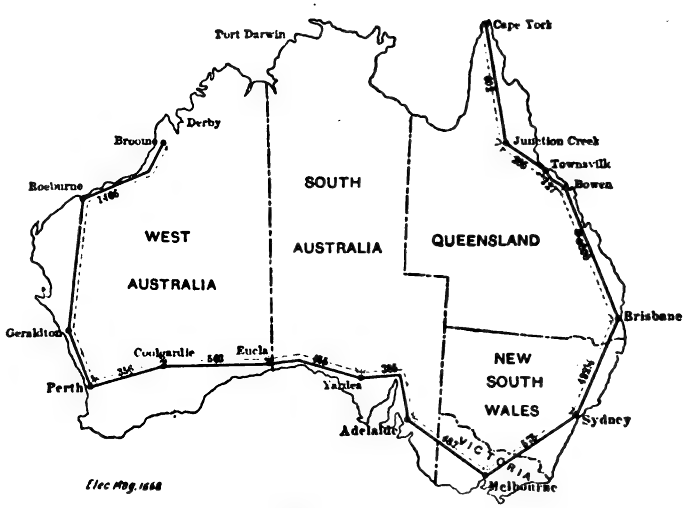
Surface Contact Tramways.

THE second of the surface contact tramways in this country has recently been put into operation after being officially sanctioned by the Board of Trade. The system adopted is known as the G. B., and

has been laid down in the streets of the quiet city of Lincoln. We have fully described the system in a previous issue, and as it is simplicity itself there is little need for us to refer to it in any detail. A bare conductor is carried on insulators in an earthenware pipe laid centrally between the running rails below the street level. This conductor is tapped at convenient points by switches pressing directly upon it under the influence of the magnets carried on the cars. The system was submitted to the most severe tests before being installed, the company's experimental track being for some months under water, but without detriment to the equipment. The operation of this system will be watched with considerable interest, though we dare prognosticate a better fate for it than that which is attending the Lorain system in Wolverhampton. While on the subject of surface contact tramways, one is reminded of the deplorable state of affairs in which Torquay finds itself at the present moment. A contract has been entered into by the corporation with the Dolter Tramway Company to furnish it with current for the operation of its surface contact lines, but before this could be fulfilled the existing one-phase plant required the addition of tramway generators and engines and boilers. A new station was at first proposed, but this was subsequently whittled down to an extension of the existing plant, which is installed in some roomy cellars on the quay side. The latest phase of the situation is that the Local Government Board, after dallying with the Council for some time, now questions the advisability of sanctioning a loan for extensions which, in addition to enabling the Council to supply the trams, would also considerably improve the position of the undertaking from a lighting point of view. The townspeople will probably feel in these days of the motor omnibus boom that it would have been better had they decided against tramways in the first place.

Long Distance Telegraphy.

Particulars have recently been published in the technical Press regarding an interesting telegraphic feat performed quite lately in Australia. This consisted in sending a message over a distance of some 6600 miles, the route covered being shown in the adjoining map. The town of Broome on the extreme west of Australia was connected with a telegraph station at Cape York, one of the most northerly points, by lengths of line stretching around the western, southern, and eastern coasts. The experiments were conducted on a Sunday morning and the chief towns were all held in readiness. After some preliminary manipulations, tuning up so to speak, Broome, which is a duplex



Map of Australia, Showing Route of Long-Distance Telegraphy Experiments.

station, was able to keep up communication with Cape York for some fifteen minutes at a key speed of twenty words per minute without any indication of lag in the signals. It is interesting to note that Broome recorded the temperature of its neighbourhood at 100° in the shade while Cape York vouchsafed similar information as 80° in its quarters. It will be seen from the map that between the two terminal points there are thirteen repeating stations, the distances in miles between them being clearly marked. This very interesting experiment was carried out at the suggestion of Mr. Jenvey, electrical engineer for Victoria, who was on an official visit to Western Australia at that time. We understand that a somewhat similar experi-

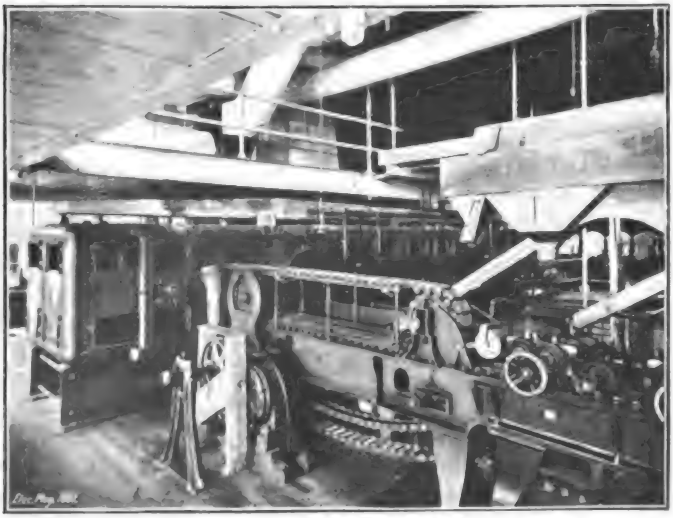
ment was carried out in 1895, but that a speed of only ten words per minute was obtainable owing to the different codes employed by the State Postal Departments.

A Huge Experiment.

In the present state of the art of electric railway traction the expenditure of some six million pounds by the New York Central and Hudson River Railroad on a system of third rail train operation can only be regarded as a doubtful experiment. We do not question for a moment the policy of suburban electrification of trains when some such system as the District Railway or the North London Railway (lines practically operated in a circle) is involved, but the wholesale employment of direct current with rotary converter sub-stations, batteries, and the third rail on so great a scale is a matter over which any of our big lines running into London or the other great termini might hesitate. The successful use of direct currents on such railways as the New York Elevated or the subway is no guarantee of the efficacy and efficiency of such a method for long distance work, more particularly on a system which extends many miles beyond the ordinary limits of suburban traffic. The New York Central will not have completed its gigantic task, of equipping some 35 miles of line with the third rail system and of building an enormous terminal station in New York for handling the electrified traffic, until some four or five years have elapsed. In the meantime electric traction developments with one-phase currents will be proceeding, and the company will shortly be faced with the problem of applying electricity over its entire system. Judging by the present rate of progress in the development of electric traction apparatus, the lines now being equipped will be operating with obsolete plant by the time they are giving a regular service. There is a great deal more than meets the eye in the action of the New York, New Haven, and Hartford Company in adopting one-phase equipment, a matter to which we referred at length in our last issue. Every credit is due to the engineers of the General Electric Company in building so efficient a locomotive as that which has been accepted for the New York Central, but mere efficiency is not everything. Those locomotives will not be fitted to run beyond the direct current zone of the system should it be subsequently decided to adopt one-phase currents for the remainder of the company's line; either then they must be adapted for both A.C. and D.C service or the D.C. portion of the system must be abandoned. Even supposing that direct currents at much higher pressures than are now common were applied throughout the system, such radical alterations would be required with the present equipment that the alternative of replacing it by new would probably be found

GRAND CENTRAL STATION, NEW YORK, AS IT WILL APPEAR WHEN COMPLETED FOR THE ELECTRIC TRAIN TRAFFIC.
(The system is described in *Traction* this month.)

the best way out of the difficulty. When one considers the complexity of polyphase generation, rotary conversion, and the use of the third rail, to all of which the New York Central is now committed, one might think that the engineers of the company had just read the late Mr. W. E. Langdon's five-year-old paper dealing with the electrification of a stretch of the Midland Railway on similar lines, and had acted upon it quite regardless of possible developments in the railway art. Mr. Sprague may exhaust his rhetoric in defending the position of his company, but he cannot in any way justify the adoption of methods which at the time of their acceptance were practically foreshadowed by something better.



ELECTRICALLY-DRIVEN BISCUIT-MAKING MACHINE AT NIAGARA FALLS.

Tuned Wireless Telegraphy.

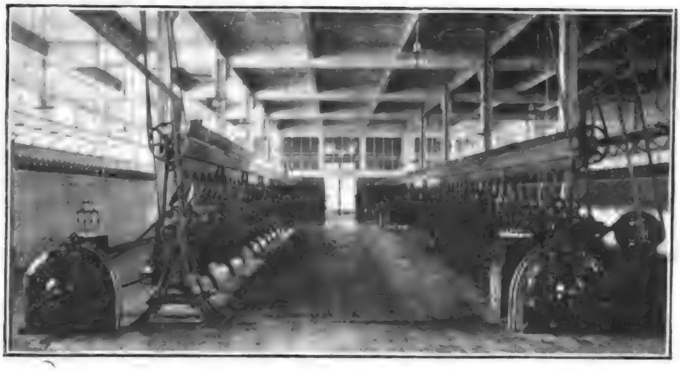
WE were recently afforded the opportunity of inspecting what has every appearance of being a revolutionary device in the field of wireless telegraphy. We refer to the system of Mr. A. T. M. Johnson which is now being developed for long-distance transmission purposes at Norman's Bay on the South Coast. Unlike a number of other systems, reliance is made in this particular instance upon transmission over the surface of water rather than through the air. The method of radiating the waves is very similar to that generally adopted, being by induction coil and spark gap, but the system of obtaining syntony is unique in that a vibrating reed is employed which can be tuned to respond to impulses representing its particular note only. We understand that the system has been inspected by the greatest experts in wireless telegraphy matters, and it has been freely admitted that the problem of a secret service has been satisfactorily solved. Doubts have only been expressed as to the distance which it is possible to cover by the system, but this the inventor and his assistants are confident of disproving at an early date. In our next issue we shall fully describe the apparatus and go closely into its possibilities and applications.

Electrical Fires.

IT was recently represented in the daily press that the roof of Shrewsbury School was set on fire through what is usually termed "the fusing of an electric wire." We have previously pointed out that our lay contemporaries are far too slack in the use of this expression, and by so doing cast aspersions on electric lighting which it does not justly deserve. It would almost seem that the reporter has only to be acquainted with the fact that a certain building was fitted with electric lights to immediately hoist out this stock phrase when anxious to explain away a conflagration. In this particular instance we are pleased to note that a prompt denial has come from the Borough Electrical Engineer, Mr. C. M. Johnson, who thoroughly investigated the matter and found the electrical installation was not the cause of the fire. He stated that the whole of the branch fuses were in order in the distributing box, showing that the damage to the wires was the effect of the fire, and was done after the main switches were turned off. It is supposed that the fire started at some distance from any portion of the electric light wiring, and may be traced to a

flue leading from the heating apparatus. Newspaper reports regarding anything electrical are now becoming almost too ludicrous, as instance the following, which is headed "Electrical Apparatus Accident":—

"At the Angel Inn, Allerton-Bywater, Castleford, on Monday night, the landlord, Frederick Phillips, and his fourteen-year-old son were examining the electric lighting apparatus to detect a flaw when a wire fused and ignited their clothing. They were injured about the face and chest."



ELECTRICALLY-DRIVEN WHEAT SHREDDER AT NIAGARA FALLS.

One could only think that the reporter in this instance has confused the electric light fittings with some antiquated gas pendant or bracket.

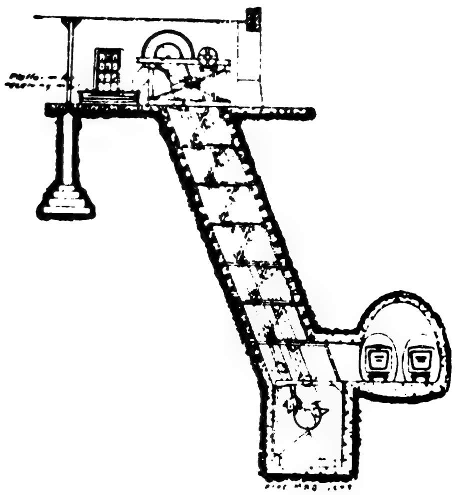
Electric Power on a Large Scale.

THE factory of the Natural Food Company at Niagara Falls is probably unique among such establishments in that all of its operations are carried out by electricity. The equipment was planned on a most ambitious scale, and according to reports the management has had no reason to regret its original confidence in and subsequent adherence to electricity as a servant. The food products of the company most familiar to our readers will be the now famous triscuit and shredded wheat biscuit. From the handling of the wheat grain to the packing of the completely cooked biscuit, human hands are not allowed to come near the cereal during the many operations through which it passes. Electrically-operated elevators, crushers, conveyors, shredding machines and baking ovens all contribute to the production of these interesting articles, but beyond starting and stopping the machinery and making certain adjustments human intervention is not necessary. The shredding machine is one of the most interesting of the group, as it breaks up the moistened and swollen wheat berry, drawing it into a number of threads which are subsequently baked to a delicious crispness. The adjoining illustrations depict the machine both in its complete length and a portion of it arranged alongside the electric oven. The entire factory is a model example of what can be done with automatic machinery operated by induction motors. Where a constant speed is necessary to insure good quality in the finished product motors of this class are invaluable, more especially when they are operated from turbine-driven generators, as is the case at Niagara Falls.

Street Lighting.

IN these days of frantic and almost despairing activity on the part of the gas interest in connection with the lighting of streets, we want all the information possible with which to combat the loose and misleading statements now being made regarding the superiority of gas over electricity. We heartily welcome the excellent paper on the subject of street lighting recently presented by Mr. Haydn T. Harrison before the Manchester Local Section of the Institution. It is not, of course, Mr. Harrison's fault, but we do certainly bewail the methods of the parent body which seem to exclude such admirable matter from its meetings. We have only received the paper at the moment of going to press, consequently cannot deal with it at length in our Lighting and Heating section, but we shall certainly do so next month, as the figures are in every way worthy of being given wide publicity. Mr. Harrison goes very closely into the principles of street lighting, and from his extensive experience is enabled to put forward data upon which every central station engineer may absolutely rely. Indeed, he may take the figures as a guide when laying out a system of street lighting, though it would be only fair that in

so doing every credit should be given to Mr. Harrison. Some highly interesting comparisons are drawn between the cost of electric lamps of every type and gas lamps of every type for street lighting purposes. These figures conclusively prove that the electrical engineer has a powerful weapon with which it will be quite possible for him to beat the gas interest at all points. Mr. Harrison shows in a number of valuable tables that comparing the total cost per annum (4000 hours) for lighting every thousand yards of main streets with electric flame arc lamps, including maintenance, is £190, whereas with gas of the latest intensified pattern the cost is £247. His other figures comparing open and enclosed arcs with ordinary high



A Typical Elevator as used for the Underground Tunnels of Chicago.

pressure gas mantles show the cost to be about the same, while tantalum lamps compared with low pressure gas mantles show a saving of £20 to £30 per annum. In the matter of arc lamps his figures clearly indicate that the flame type of lamp must be exploited both against high pressure and intensified gas, and the improvements now being effected in this type of lamp should not make an active campaign on these lines a difficult matter. We cannot do better than quote a few of Mr. Harrison's concluding remarks in his paper. He says: "I trust I have been able to prove to you that you have at your disposal in electricity a force that if properly applied can be used for lighting streets more efficiently and at a less cost to the ratepayers than any other form of illuminant available. Those who have studied the matter carefully are aware that in nine cases out of ten the lighting of the streets still remains in the hands of the gas companies, simply on account of the business push and acumen of their managers. Is it surprising that gas companies in many cases retain this branch of the business when many electrical engineers are so disinterested in the matter as not to trouble to find out what can be done?"

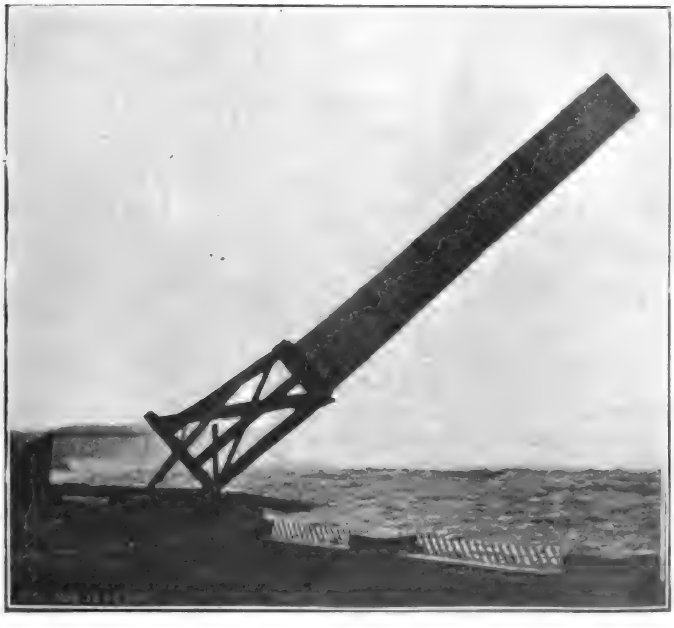
Chicago's Freight Tunnels.

The net-work of tunnels under Chicago is now beginning to be put to the uses for which it was originally designed. According to our contemporary the *Western Electrician*, the term "New Chicago" has been applied to the system, which furnishes to a certain extent a duplicate set of streets to those on the surface. Locomotives of various sizes and types are being employed in the tunnels, and as we have previously pointed out in referring to the system, both the overhead trolley and a rack form of collector are in use. Provision is being made for the cartage of almost everything, from mails to merchandise, and no opportunity has been lost of conveying material efficiently from the surface. Elevators and shafts of every description are being sunk, while in some instances the basements of buildings are being carried right down to the rail level. The Tunnel Company is erecting its own power house, which will furnish some 5,000h.p. for the operation of the trains. Direct current at 250 volts is at present in use, the service for both light and power being given by the Chicago Edison Company. In the handling of coal in a number of instances a gravity system has been adopted, by which the coal passes from hoppers down chutes into the tunnel, the receiving end being provided with two branches, so that two cars can be loaded from the one chute. An automatic telephone is erected at each street intersection, and a telephone system is in use for the despatch of trains.

Concrete Poles for Transmission Lines.

Every week brings news of fresh uses to which concrete is being put. The concrete arch, the concrete building, and even the concrete chimney are things to which we have now become accustomed.

The power-transmission engineer will doubtless be glad to hear that the concrete pole for supporting his overhead lines is now a *fait accompli*. According to the *Canadian Electrical News*, reinforced concrete poles are employed for supporting the transmission lines on the Welland Canal. The poles were manufactured *in situ*, with their butt ends immediately over the hole intended to receive them. It was found necessary to adopt this course because of the great expense of transporting such heavy weights. A 35ft. pole, we are informed, weighs about 2½ tons, and a 50ft. pole about 5 tons. The poles have been made square, with chamfered corners, the reinforcement of the material being obtained by the use of steel rods. The poles do not require painting, and it is claimed that their life is indefinite, as the weather is supposed to have no action upon them. In the matter of cost the figures given show a saving of 25 per cent. over steel poles of similar strength. The poles have a very pleasing appearance, and, compared with either wood or steel, look more ornamental for town use. At present, wooden cross-arms are used on these poles for carrying the insulators, but experiments are being made with reinforced concrete arms.



Concrete Dam being Tipped into Water at Niagara Falls.
The column took one and a-half hours to cant over.

Dam Constructing Extraordinary.

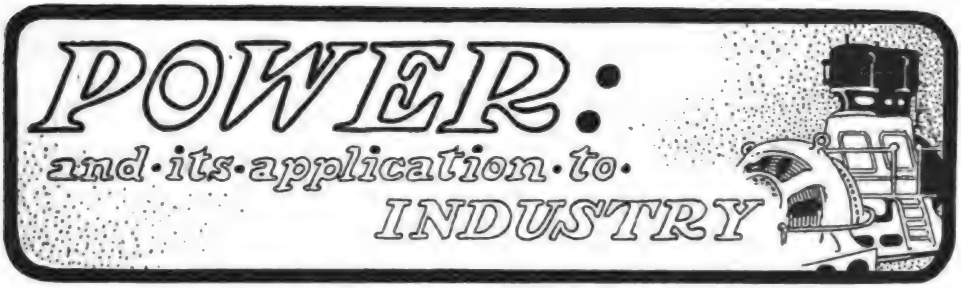
Probably for the first time in history a dam weighing 200 tons has been erected on land and dropped into the water. Prehistoric man may have felled trees with a similar object, but until recently his example has not been followed on a large scale. Particulars are now to hand, however, of a project which has since been successfully carried out for increasing the depth of water in one of the intakes of a power plant at Niagara Falls. It was found that sufficient water could not be made to enter the intake under normal conditions, and the construction of a dam at the lower point was decided upon. As the intake is just above the lip of the Falls, the difficulties of building a dam were considerably increased, and hence the proposition to build the dam on shore and drop it into the water. It was constructed of concrete and built up to a height of 50ft., its dimensions being 7½ft. square. A heavy chain passed through the centre of the column, which was further arranged to break up into six pieces after its fall. We have taken the adjoining illustration, which depicts the column in the act of falling, from the *Scientific American*, and we gathered from our contemporary that the results of launching this unique pillar have more than realised anticipations. The column was set up on a tressel designed to give it a throw of some 15ft. from the shore at its fall. This was arranged to provide an ice run between the end of the column in its recumbent position and the shore. About an hour and a-half was required to tip the column, three hydraulic jacks being employed under the timbers. After its fall into the water the depth of water in the intake was increased by 10½in., and it is understood that this will furnish the additional amount which it was hoped the presence of the dam will provide.

We notice that since the dam has been

dropped into position a strong adverse criticism of it has appeared in one of our American weekly contemporaries. The engineer writes stating that the force of the water is likely to carry the outer end of the dam down stream and so alter its position that ultimately its purpose will be quite nullified. Again, it is urged that this defect cannot be remedied as the blocks forming the dam cannot be added to nor buttressed in any way to withstand the water pressure. The writer suggested that a rectangular structure should have been lowered into the water by cranes, and if it showed signs of moving, the central portion could be filled with blocks of stone. This seems in the circumstances the more feasible plan, but as in so many other things one is always wise after the event.

The Additional Electric Power Company.

THE scheme of the Additional Electric Power Supply Company, which is being put forward to furnish London with power supply in bulk, and to which we alluded in our last issue, has much in its favour to recommend it. Among all the other propositions it seems to us to contain rather more of the elements of success. The promoters cannot certainly be accused of copying from any of the other schemes either as regards the site of the generator station or of the method of transmission and distribution. The power station is to be situated on the Ouse near St. Neots, some 50 miles from London, but in this position of splendid isolation it will, by an arrangement with the Great Northern Railway Company, be assured of a cheap coal supply. The estimates set the cost of fuel at from 5/6 to 6/- per ton delivered into the bunkers, a figure which is some 3/- per ton lower than that given by the Administrative County of London Power Company. Obviously this cheap rate is a concession on the part of the railway company, which can certainly afford to make allowances to a customer requiring some 300,000 tons of coal during the course of a year. Again, the railway company is not blind to the importance of being on the best possible terms with a power company which may furnish it at no distant date with energy for the operation of any electrified sections of its system. The transmission of power to London is to be effected for the most part by overhead lines, and in the route chosen for these the railway company again figures prominently. It has granted concessions for the erection of the poles along the line of its main tracks so that the power company will have no need to seek for a special right of way nor arrange for any special safeguards for the public. A striking feature of the distribution in London is the suggestion that the cables be laid along the routes of canals and railways in the metropolis. A glance at a railway map of London will at once show that such a suggestion would bring the service of the company within reach of the majority of the existing electric supply authorities. It is these latter which the new company desires to reach with its main feeder cables, as in the strictest sense of the term no subsidiary network will be laid down. The proposal is merely to furnish electrical energy to the existing undertakers, who would become the authorised distributors of the new company. There is to be no competition with the authorities now giving supply, and this circumstance adds materially to the value of the proposals to lay the mains in the manner suggested. A scheme of this nature seems to us to possess everything in favour of giving an exceedingly cheap supply of electrical energy to the Metropolis. The co-operation of the Great Northern Railway Company in the matter of fuel supply and transmission line, and similarly the cable facilities afforded by the London railways, relieve the promoters at the outset of the very heavy capital expenditure invariably necessitated by the laying of underground mains along special routes, not only in the country but more particularly through the towns. Such arrangements would also conduce largely to the giving of a supply at a comparatively early date. The scheme is by far the most feasible put forward for London and we think that it is in every way deserving of success. It must not be forgotten that with several rival schemes to oppose it in Parliament, a project of this nature does not always receive consideration on its merits, and a species of obstruction may be encountered which disregards both the real aims and avowed objects of the promoters. Should such tactics wreck the Bill of the company with which we are dealing, the effect will be a set-back for electricity supply in bulk on a highly economical scale and under conditions difficult of reproduction with schemes involving heavy initial capital expenditure for costly transmission and distribution systems.



Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

A Great Mexican Hydro-Electric Plant.

THE mountainous regions of the world, among which Mexico may be included, are now being regarded with greater interest and concern than formerly by the engineer, for so successful has been the practice of hydro-electric plants in all parts of the world that a land abounding in mountains cannot fail to escape notice. Mexico is now being committed to a large scheme, and, though by no means the first of its kind, it presents so many features of novelty and value that a detailed description of it will make good reading. We have taken the bulk of the following data and illustrations from the *Electrical World.*

The scheme referred to is being carried out in the Republic of Mexico and is connected with the utilisation of the Necaxa Falls by the Mexican Light and Power Company under the initiative of Dr. F. S. Pearson. This great enterprise has as its field of operation the great central Mexican plateau, where it is developing and conserving the energy of the Tenango and Necaxa Rivers. At a point 100 miles north-east of the City of Mexico these rivers debouch from the mountain chain at a height of about three-quarters of a mile above the sea, their joint flow being discharged finally into the Gulf of Mexico. These two rivers drain jointly an area of about 227 square miles, and on account of the geological nature of the plateau encountered a remarkable succession of waterfalls resulting in a total drop of more than 3000ft. in a distance of three miles. The Tenango River has been consolidated with the Necaxa by diversion, and their joint flow has been stored in a reservoir lake at Necaxa. From this reservoir by a tunnel and pipe line the water is carried to the first power plant with a total drop of 1470ft. in a mile. It is thus utilised at the first power house, but will ultimately be utilised again at the end of another drop of 1100ft. The two plants are to have a final capacity of not less than 80,000h.p., and the power is to be carried by a transmission line from the first power house to the City of Mexico, and also far beyond that point to the mining district of El Oro, giving a total line transmission of 171 miles.

A Comparison in the Size of Power Transmission and Telephone Insulators.

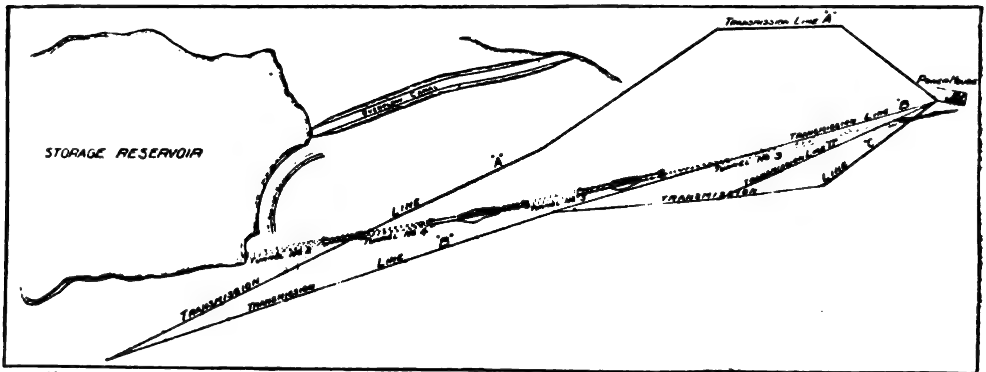
The engineering involved is of a most able and ingenious character, and the plant when completed to its full capacity will present many features of surpassing interest. The dam of the Necaxa Lake is of earth 177ft. high and 600ft. long, with a base width of 950ft. and a width of 54ft. at the top. No less than 2,000,000 cubit yards of material were required for the wall, obtained chiefly by blasting. A three-square-mile lake has thus been created from which the impounded water is carried off by means of two pipe lines, running in a series of tunnels 1500ft. long. Beginning with two vertical intakes with gates at different levels, these pipes end in a receiver from which six seamless steel tubes are carried to the power house itself.

The horizontal penstocks are 8ft. in diameter and $\frac{5}{8}$in. thick, passing through the first tunnel, after leaving which they narrow down to 6ft., and run down stream for 2800ft. of which distance the pipes are partly in tunnel, partly in open cut, and partly in piers, crossing and recrossing the windings of the river. Then under a head of 180ft. the penstocks empty into the receiver, 22ft. long and 7ft. in diameter, out of which proceed the six 30in. smaller pipes leading to the power house. The two halves of the system can be separated from each other, and either part run without interference. All the pipes are connected to the receiver through gate valves. The pipes from the receiver descend a distance of 2300ft. to the power house, of which 1900ft. is in two parallel tunnels at an angle of 41° from the horizontal. In each tunnel there are three pipes supported on concrete, with anchorage and expansion joints.

The initial apparatus in the main power station No. 1 has been furnished by the General Electric and Siemens-Schuckert Companies, and comprises six 5000kw., 4000 volt, 50 cycle, 3-phase, vertical shaft generators of Siemens-Halske construction. Each generator is driven by an impulse water wheel carrying 24 buckets at its periphery. They are 100 inches pitch diameter, running at 300 revolutions per minute, and each has two 4½in. square regulating nozzles fixed on opposite sides of the wheel but operating together. The current from the generators is delivered to eighteen 2000kw. transformers stepping up to 60,000 volts, the outfit being divided into six banks of 6000kw. each. The transformers are oil-immersed and water-cooled.

The power house No. 1 in the Necaxa Canyon itself is a massive building of steel and masonry, 235ft. long, 88ft. wide, and 60ft. high. All the material for its construction, as well as the apparatus for the plant, had to be transported with great difficulty, and finally to be swung down over cliffs and by means of inclined cableways some 1500ft. before it could be assembled at the point of utilization. The power house is equipped with a 40-ton electric crane for handling all apparatus, and special attention has been paid to the machine shop equipment, as it will be readily understood that a plant in such a position is not favourably situated for getting any of its repairs done outside, but must be furnished with the means for grappling with even the largest job of that nature.

The transmission system includes four three-phase, 10,000kw., 60,000 volt transmission lines, as well as a local power and

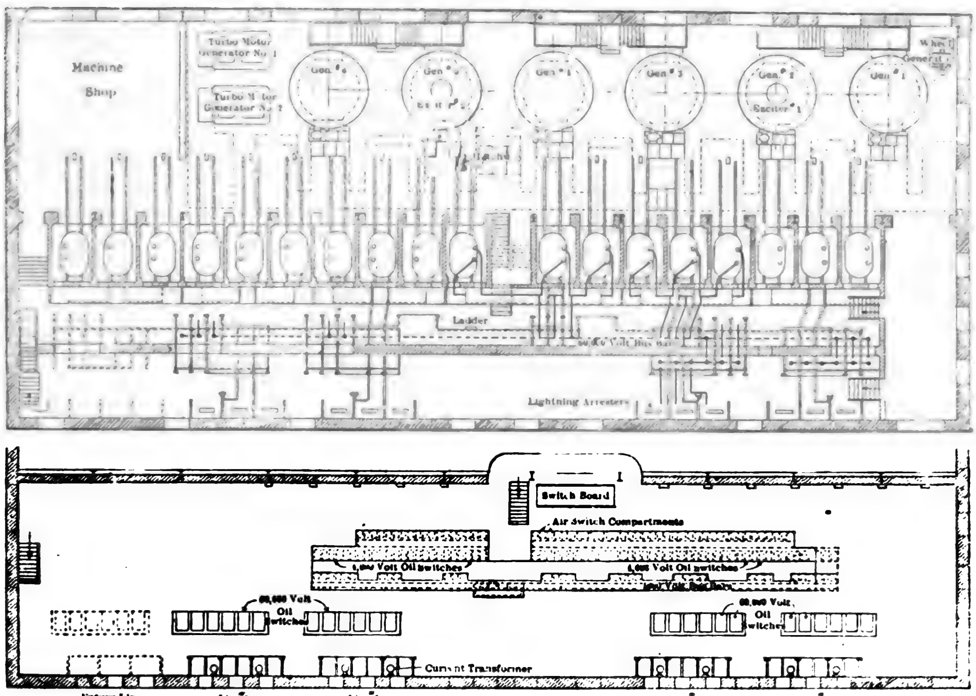


Elec. Mag. 1849

General Plan of Transmission Line and Tunnels in Necaxa Power Plant Scheme.

lighting service. To insure stability of construction and permanence as well as continuity of supply, steel towers have been used for the transmission line, there being two of these carrying the four separate circuits direct into the City of Mexico and two separate circuits from the City of Mexico onward to El Oro. The steel towers are 40ft. high with 500ft. spans, or higher when the spans are strung to a length of 1200ft There are 534 miles of circuit and 1602 miles of aerial cable. At full load the loss between been assembled and cemented on the spot, and although receiving a test before shipping, while wet, of 60,000 volts, are again tested when assembled with 120,000 volts potential. The insulator pins are set into the insulators with Portland cement and are 15in. long, of 2in. steel pipe, set in drop forged sockets, mounted on a 4in. pipe cross arm for the lower cables, and 3in. for the upper. The towers carry also No. 10 copper telephone circuits, .10ft. below the cables.

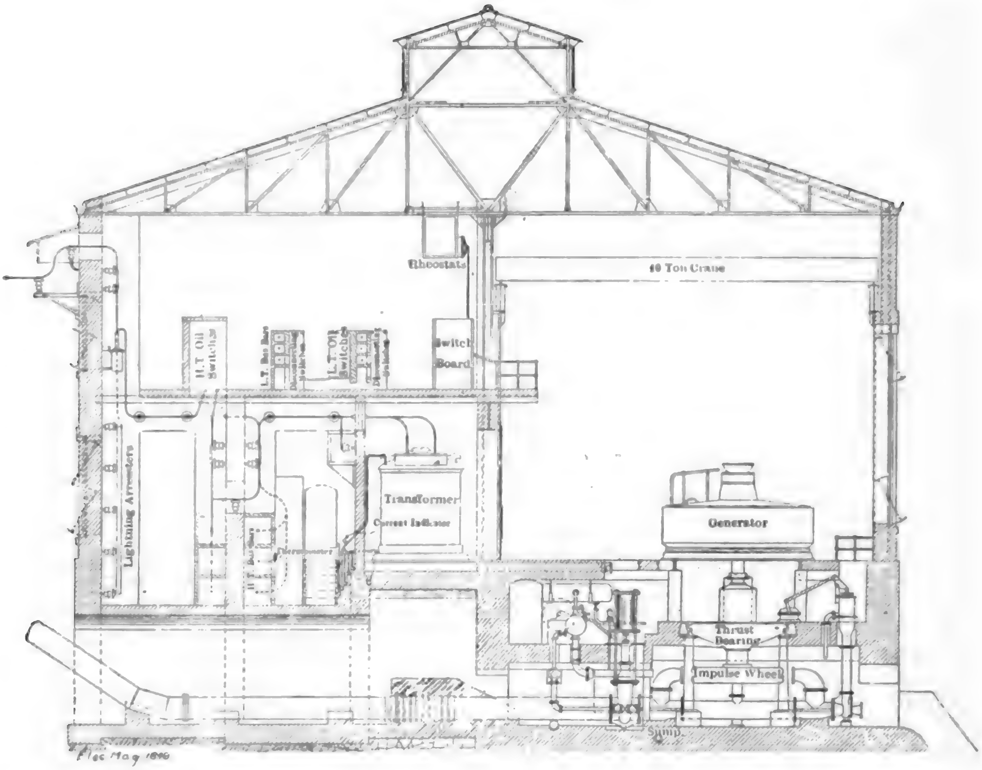
The sub-station work at the City of Mexico



INTERIOR PLAN OF THE POWER HOUSE, NECAXA, MEXICO.

Necaxa and the City of Mexico is 8 per cent., and from the City of Mexico to El Oro 5 per cent. more.

The transmission towers, set 5ft. in the ground, are built of angle steel, heavily galvanized, with $3 \times 3 \times \frac{1}{4}$in. posts for the corners spaced 14ft. apart across the line and 12ft. along it. The cables are carried 40ft. and 46ft. above the ground and are six strand copper, $\frac{1}{2}$in diameter, shipped in lengths of 3000ft., and with joints made with 18in. twisted copper sleeves. They are attached to the insulators by clamps instead of tie wires. The insulators have is connected with a re-modelling of the old steam station, in which four turbo-generator units of 500kw. each are being added. The equipment of the sub-station includes twelve 1800kw. oil transformers in separate fireproof compartments, with switching and wiring also in separate cells. The transmission can be at 20,000, 40,000, or 60,000 volts, and the step-down transformers are arranged to furnish current at 1500, 3000, or 6000 volts. The sub-station at El Oro has nine step-down transformers of 1800kw. each, similar to those in the City of Mexico. In the latter place ordinary city distribution

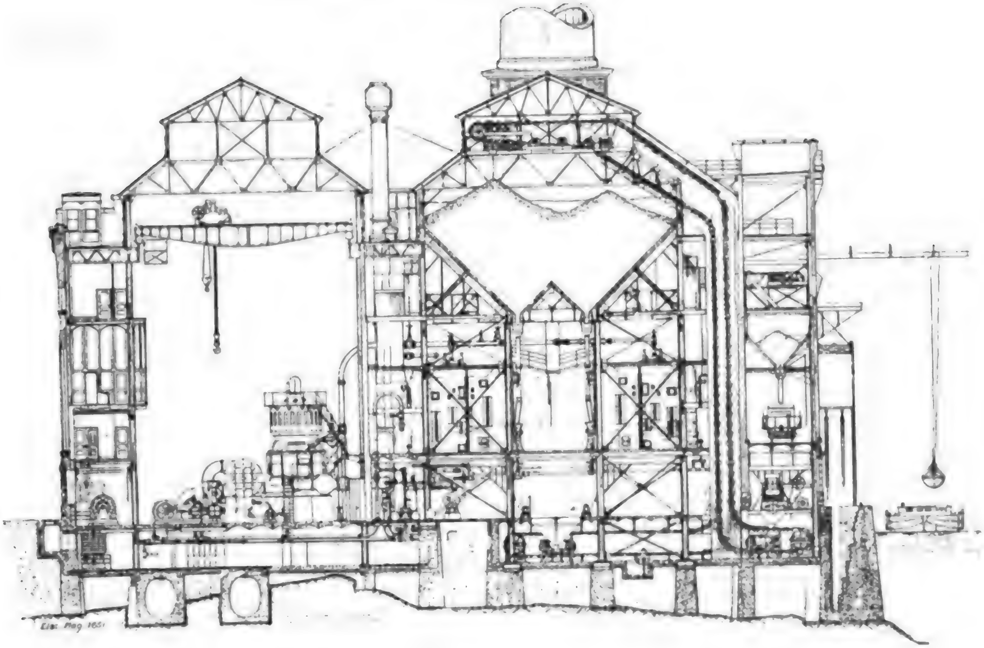


SECTIONAL ELEVATION OF POWER HOUSE, NECAXA, MEXICO.

is dealt with, but at El Oro the current is to be used chiefly for mining operations on some of the largest veins and ore bodies of gold in the world. The work on this great enterprise is now virtually complete so far as power plant No. 1 is concerned.

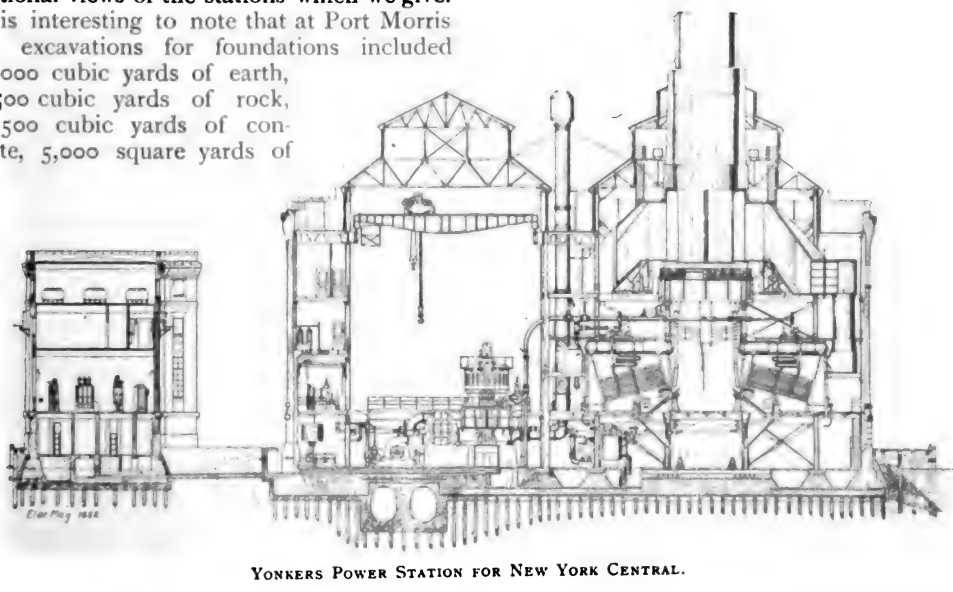
Two Great Railway Power Houses.

THE new suburban trains of the New York Central and Hudson River Railroad which are to be electrically operated will be furnished with current from two large power houses which are at present in course of construction. We have already referred to the design and arrangements of these, and as full details and drawings have now been published we are able to present our readers with sectional views of the plant. As might have been expected, the company which would adopt electrification on so large a scale and spare no expense to include only the latest apparatus on the line and rolling stock would spare nothing to ensure that the generating plant itself should be of the most modern and the most highly efficient character. The stations are situated at Yonkers on the Hudson division of the road and at Port Morris on the Harlem division, and each has a gross output of 30,000kw. We are informed that this capacity is sufficient to take the load of a train service considerably in excess of that now running under steam conditions. The sites have been carefully selected both with respect to the load centres of the electric traction system and proximity to water and rail. It will be seen from the illustrations that the plants are very similar in design, and that the maximum of output is being obtained from the minimum of space. The number of cubic feet per kilowatt capacity is, we understand, 102, and the number of square feet of building per kilowatt is nearly 1½. In the case of the Port Morris Station it was possible to lay the foundations on solid rock, but for the Yonkers Station piling had to be resorted to, a hard bed of sand and gravel being struck at that particular spot. The great disproportions of the boiler and turbine



PORT MORRIS POWER STATION FOR NEW YORK CENTRAL.

houses will be noticed at each station, but this can only be expected while the steam-raising plant remains as it does at present. Again, provision must be made over the boilers for the storage of a very considerable tonnage of coal. The disposition of the boilers, coal-conveying plant, flues and stacks, will be clear from a close study of the sectional views of the stations which we give. It is interesting to note that at Port Morris the excavations for foundations included 26,000 cubic yards of earth, 4,500 cubic yards of rock, 16,500 cubic yards of concrete, 5,000 square yards of waterproofing, and 25,000 cubic yards of back filling. Particulars of the waterproofing state that six-ply material was used in all horizontal planes, five-ply in vertical planes, and four-ply around ducts exposed to surface or tide water. As might be expected, the buildings are of steel framework filled in with brick and tile, and the

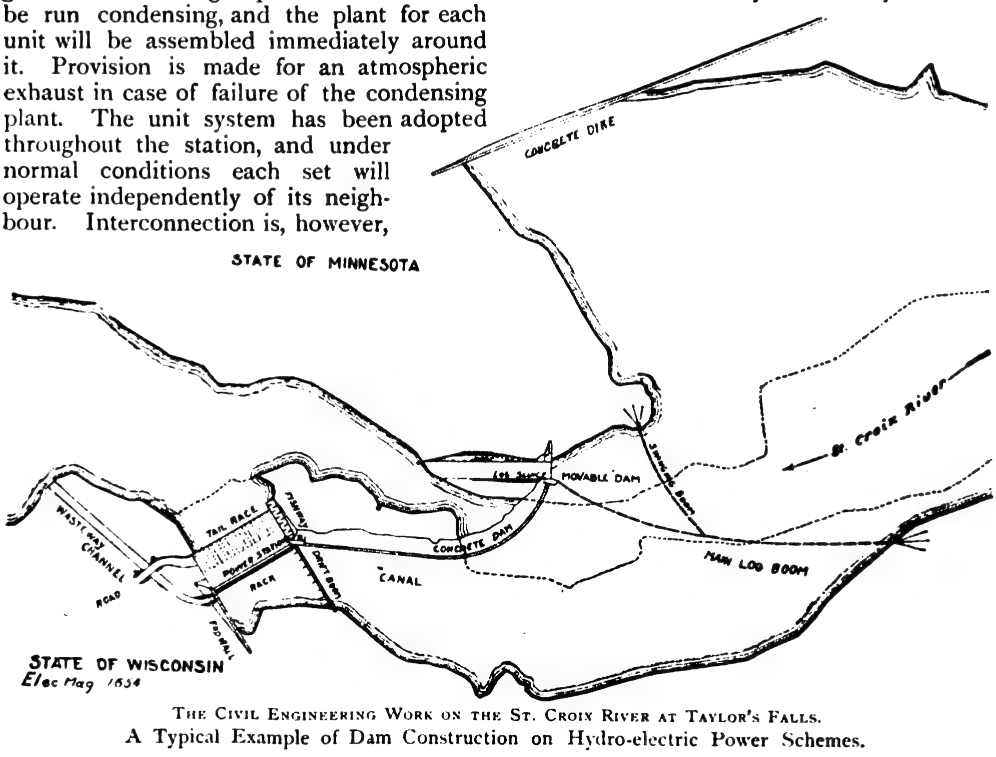


YONKERS POWER STATION FOR NEW YORK CENTRAL.

roofs are of concrete slabs covered with copper. Some 2,800 tons of steel are used in each section. Departing from usual American practice, in the appearance of the station the purely utilitarian has not been allowed to predominate, but a more or less ornate design has been adopted.

The stacks rise from the boiler house roof and are supported on steel columns and a concrete and steel staging 40ft. above the boiler room floor. This practice differs entirely from anything which is done in chimney direction in this country. Over here the chimney generally rests on its own foundation and is quite independent of the main building. The equipment of the two stations will be practically the same—twenty-four water-tube boilers each of 625h.p. and six 5,000kw. turbo-generators. The boilers will operate at a normal working pressure of 185lbs. and steam will be superheated to 300°F. above the temperature due to steam pressure. The steam piping will naturally be of mild steel with flange joints. Four boilers are told off to serve each turbine and are piped direct to it, though cross connections are provided so that supply can be given to the next group. The turbines will be run condensing, and the plant for each unit will be assembled immediately around it. Provision is made for an atmospheric exhaust in case of failure of the condensing plant. The unit system has been adopted throughout the station, and under normal conditions each set will operate independently of its neighbour. Interconnection is, however, made possible on both the steam and electrical sides of the plant.

The generators are star-wound with neutrals grounded through separate cast-iron grid resistances coupled to a common bar. Three-phase current is generated direct at 11,000 volts pressure, the frequency being 25 cycles. Two 150kw. turbo-generators and one 150kw. induction motor generator will furnish current for excitation and the operation of the switch gear. A battery of 1,200 amp.-hours capacity is being installed as a stand-by. The switch gear is being housed in entirely separate buildings at both stations, and is electrically operated throughout. The bulk of the high-tension connections which will be in any way exposed are being placed in chambers in basement of the switch-house, and only authorised workmen will be allowed to enter. Switching units comprising one generator and three feeder panels are arranged for, and each such set is separated from similar units by fireproof walls in the basement. The connections between the oil switches and the busbars are being made with bare copper tubing, and it is stated that the arrangements are such as to dispense with the use of insulators. The auxiliary machinery in each



THE CIVIL ENGINEERING WORK ON THE ST. CROIX RIVER AT TAYLOR'S FALLS.
A Typical Example of Dam Construction on Hydro-electric Power Schemes.

power-house requires an aggregate of 240h.p. in A.C. motors and 180h.p. in D.C. motors.

These stations represent the highest achievements in the design of power plants for railway operations up to the present time. The policy of isolated units has been laid down and faithfully followed out so that all possibilities of interruption of supply have been allowed for. The equipment may well be taken as the pattern for any railway scheme, whether its trains be fed by alternating or direct current. With the intervention of rotary converters between the generators and the trains a number of complexities are certainly introduced, but this in no way detracts from the value of the principles laid down. If a railway company was purchasing its power from some outside source, in its own interests and those of the travelling public it would be compelled to request that somewhat similar precautions to obviate breakdown should be taken by those furnishing it with the necessary electrical energy.

Motors and Gun Making.

It has been stated that the stability of a nation now depends on its straight shooting, and that unless "the man behind the gun" has a good weapon and true he might as lief be given a carrot to shoot with. Now guns, like other things, have to be made, and with the utmost accuracy. That little word means a great deal, and it is indissolubly bound up with another—efficiency—in the workshop. We do not need educating up to the value of the electric motor for machine tool drive, and unless our Government departments keep up to date in installing electric power in the great workshops of our Navy we may expect to meet trouble. The recent paper of Col. H. C. L. Holden, read before the Institution of Electrical Engineers, gave some interesting facts of what is now being done at Woolwich Arsenal in the matter of electric driving. His remarks contain detailed references to a large number of tools, but we have extracted the following as being of considerable interest and value.

Although there were previously several instances where in the Factory electro-motors had been substituted for steam engines, it was only in 1900 that I converted the first of two large boring machines to a direct electric drive by means of a variable speed Schuckert 4-pole motor of 25 B.H.P. The variation of speed was obtained by the now well-known method of varying the excitation of the fields, and the ratio in this case was 1 to 3·5 or so, giving speeds of from 250 to 880 r.p.m., which is amply sufficient range, without any further gear, for the work that is put into these machines.

The machines themselves are of the simplest possible description. The headstock which revolves the work carries between its bearings a large worm wheel, which is driven by a worm shaft forming a continuation of that of the motor, but connected to it by a flexible coupling; the thrust of the worm shaft, which in such large machines is very considerable, amounting to tons in some cases, is taken by a thrust bearing of marine type, and through this the cutting lubricant passes on its way to the boring bar; this is only a precautionary measure, but, nevertheless, a necessary one, as not only is it very important that the machines should not stop during a boring operation, but also, as they have to run from early on Monday morning till late on the Saturday night, and are only stopped for shifting or adjusting the work or tools, it is imperative that any trouble that could arise from a heated bearing should be guarded against; and I am happy to say that so far there has not been a single machine stopped from this cause. They run absolutely silently and without jar or vibration; indeed, in this respect the worm and worm wheel, together with the electro-motor drive, is ideal; and even if it have the defect that it is slightly less economical than spur gear, this loss is more than compensated for by the extra accuracy of the work done and the freedom from breakage of tools. It would be impossible in a spur gear driven machine, I believe, to fine bore a hole 12in. to 20in. in diameter and up to 50ft. in length without a variation of 0·004in. in diameter, which is what these boring machines are called upon to do, and do to perfection, daily.

The feed of the boring bar in the machines described is worked from the motor by means of a shaft, which connects it with change gear, similar to that of a lathe, at the other end of the bed, 150ft. away. At this end there is also a 15h.p. series motor, which can be mechanically coupled to the screw shaft moving the boring head and saddle, with the object of withdrawing or advancing one or both rapidly in either direction as required; in this case I have introduced a

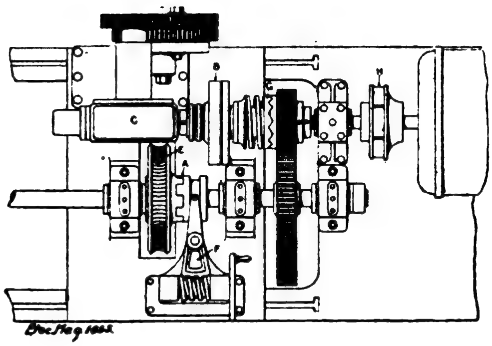


Fig. 1. Method of Motor Drive for Large Boring Machines.

pinion, and the overload clutch G, and an armature. The worm gears into the worm wheel above it, from which the change gear D, similar to that of a screw-cutting lathe, and situate behind the worm wheel, drives a horizontal shaft on which another worm engages with a second worm wheel E. This latter can be clutched mechanically by the claw clutch A to the screw shaft I actuating the saddle. The claw clutch A is moved by a hand-wheel in and out of position, and the lever F that moves carries a contact which only allows of the magnetic clutch B being in action when the claw clutch is disengaged. Thus normally the drive is through the worm wheels and the change gear, but when it is desired to move the saddle quickly the magnetic clutch is energised and the pinion on the motor shaft then drives a spur wheel which is keyed to the screw shaft I, the latter being thus driven direct. The feed can be varied practically to any extent required between the extreme limits by the combination of change gears and the varying speed of the motor. This gear is worked entirely from the main switchboard by which the man

slip coupling which in the event of an overload not only slips, but also draws attention to the fact by making a hideous noise; this is, I think, better in many ways than the overload release, and much more convenient, of course, than a fuse which has to be replaced. It may be interesting to you to know that the change to motor driving and the improved control of the speed enabled us to turn out at once more than double the former amount of work done per week. It was considered necessary at first to put the control of the speed in the hands of the foreman only, and for him to lock up the shunt regulator; this is now found to be an unnecessary precaution.

A later development of this method of driving is one whereby the driving shaft, just mentioned as running the whole length of the bed, is entirely done away with, and the one motor, now a variable-speed shunt motor, does all the feeding of the boring bar, as well as the rapid advancement and withdrawal of it and the saddle, the latter weighing ten to twelve tons or more. How this is effected is shown in the diagram of this feed gear in Fig. 1.

The action of the gear is as follows:—The motor drives the shaft through a flexible coupling H. This shaft carries on it the magnetic clutch B, and beyond the clutch the worm C. It also carries on a sleeve a

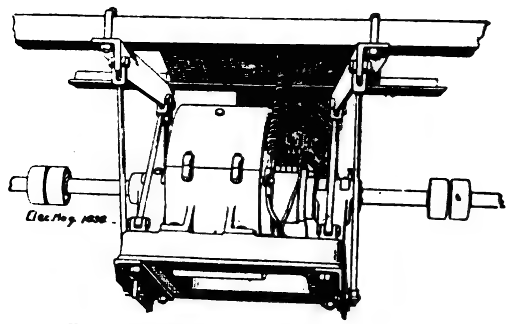


Fig. 2. Method of Driving Line Shafting with Separate Motors.

starts and stops and controls the speed of the headstock carrying the gun-tube, and the switches are so interlocked electrically that it is impossible either to start the feed gear or to leave it running unless the main motor is running. Fig. 2 depicts a special support adopted for motors driving lengths of shafting.

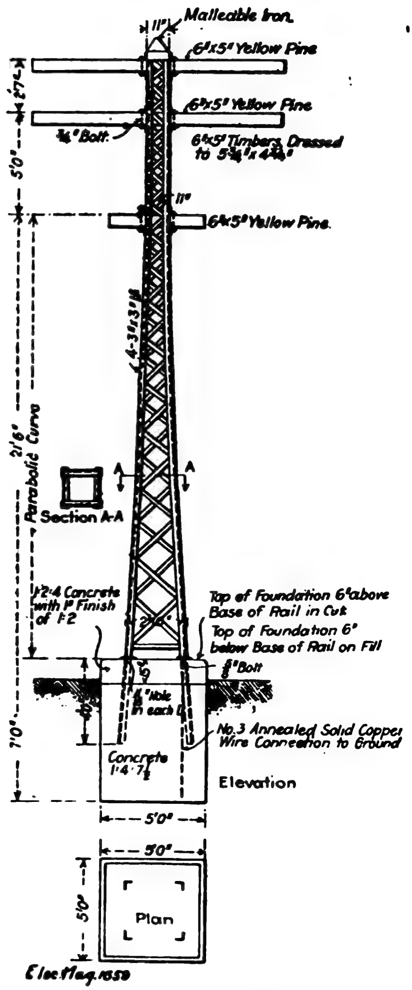
A classified list of Traction and Transport articles will be found in the World's Electrical Literature section.

New York Central Electrification.

WHAT is at present the most gigantic task in the matter of main line electrification is now being proceeded with on the suburban system of the New York Central Railroad. We have had occasion to frequently refer to this system, and quite recently considerable attention has been paid to it by our American contemporaries, consequently there is a large amount of interesting information available. The proposals of the company are of the most ambitious character, though as far as can be seen this will not in any way prevent their being brought to practical fruition. We have already described and illustrated the locomotives to be used for the long-distance traffic, and in our last issue gave very full details of the attitude of the company's chief electrical engineer towards the employment of one-phase apparatus over the system. We now propose to give some particulars of the Grand Central Station to be erected in the heart of New York City, and of the third rail and transmission apparatus. The two monster power houses now being erected are described fully in the Power section this month.

The new terminus will be unique in that it has been designed to accommodate electrically operated trains only. This fact has enabled the engineer to arrange the long-distance and suburban traffic in two tiers, the upper one for the heavy locomotives and main line traffic, and the lower for multiple unit cars running the suburban service. Some two hundred buildings, including residences, shops, apartment houses, churches and hospitals have been demolished in the clearance of ground for the building operations, which have been going on since August, 1903. The suburban tracks will be 35ft. below the level of the present lines, and will cover about 15 acres. This area will

CABLE HOUSE AND THIRD RAILS OF NEW YORK CENTRAL LINES.

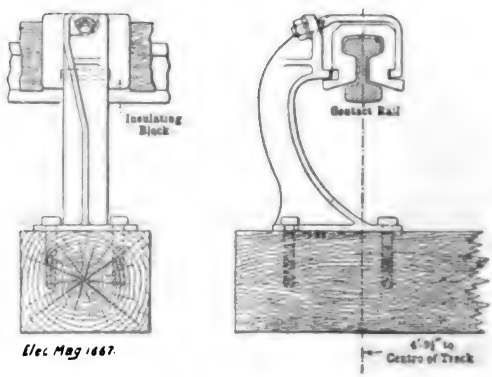


Transmission Tower as Used on New York Central Electrified Tracks.

accommodate over 5 miles of tracks and these will come to the surface by easy gradiants. The upper range of lines dealing with the long-distance traffic will cover some 20 acres and allow of the laying down of over 6 miles of track.

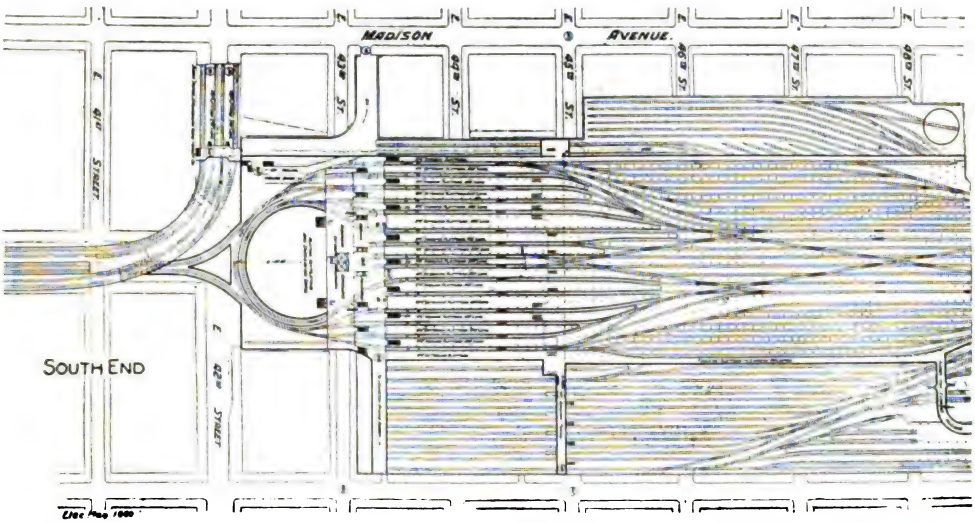
The most elaborate preparations are being made for the entrance and exit of passengers and vehicles to the station, and the arrangements for handling baggage are to be exceptionally complete. We give an illustration of the suburban level in which there will be some forty-seven different tracks, and separate platforms are being provided for incoming and outgoing passengers. It will be noticed that a loop is provided to admit of trains passing from the up to the down line.

The transmission line for the system will be partly overhead and partly underground. We illustrate one of the steel towers employed for the overhead line and also a cable house adjoining the electrified track. The overhead conductors will be either of aluminium or copper wire cable, spaced 36 inches apart on the cross arms. These latter will be of yellow pine, but the insulators will be supported by steel pins. For straight runs a 150ft. span has been adopted, but this will be considerably reduced on curves. The underground cables will be of the three core type with paper insulation and lead covering, the cables being drawn into earthenware ducts covered with water-proofing and laid in concrete. In the inspection manholes, placed at certain intervals, the cables lie on a concrete shelving supported on iron pins. The shelving can, of course, be removed to facilitate the inspection of the cables. The design of the sub-stations calls for no special remark, although exceptional care has been taken to prevent any possibility of interruption of the supply. Storage batteries have been introduced and will sustain the entire load of the particular substation for at least one hour in case of failure of the converting plant. Provision is made for starting the rotaries from either the direct or alternating current side. With the latter a variable ratio transformer is employed. The direct current feeder arrangements provide for a duplicate supply to separate sections of the third rail. At the section points arrangements are made to prevent



Inverted Third Rail as Adopted for New York Central.

bridging, and switches are also provided at the third rail to cut off supply at that point should there be a ground between it and the station. There are four tracks and consequently four third rails, and these are joined together through circuit breakers in small houses placed at intervals along the line. We give an illustration of the arrangement of third rail adopted, and it will be seen that the very simple form of hanger employed at once dispenses with the difficulty of properly insulating the rail from accidental contact. By inverting the contact surface in this way it is also possible to obviate troubles with snow and more particularly sleet. The latter has frequently held up the electric service on the overhead lines in New York, and it is naturally desirable that occurrences of a like nature should be avoided on a system where many more trains and a heavy volume of traffic will be dealt with. We give in our editorial columns this month an illustration of the Grand Central Station as it will appear when complete, and also allude to the adoption of direct currents by the company as a doubtful experiment. In the face of what has already been done with one-phase currents it is certainly a matter for some doubt as to whether the New York Central may not find it necessary to ultimately abandon all their very costly direct current equipment.



SUBURBAN LEVEL FOR ELECTRIFIED TRAINS, GRAND CENTRAL STATION, NEW YORK.

Swedish Electric Railway Experiments.

EXPERIMENTS with one-phase long-distance electric trains in Europe have up till recently been confined to some half-a-dozen isolated stretches of line, each operating with a different type of apparatus. We have already announced the original intention of the Swedish Government to utilise its extensive water powers for the operation of its State railways. We now understand that the work of bringing this scheme to a practical issue is well in hand and that experiments are being conducted with different forms of one-phase railway apparatus with a view to determining the selection of the most suitable class for the purpose. Such a combination of hydro-electric power houses and an extensive main line system of railways as is suggested seemed to the undertakers to quite preclude the consideration of continuous current in any shape or form. This particular system has accordingly been ruled out of the reckoning. The respective merits of one and three-phase currents have also been taken into account and after due deliberation the decision was given in favour of the former. It now remains for the electrical advisers of the Government to make up their minds as to the best apparatus to be used, at the power house, for the over-

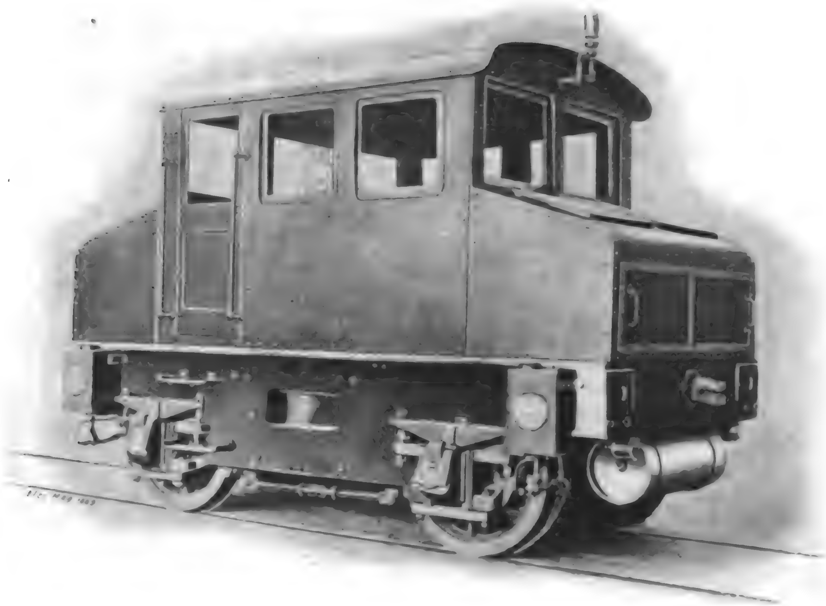


Fig. 1.—One-phase Locomotive, as being experimented with by Swedish Government.
The collectors and buffers are not in position.

head line and for the equipment of rolling stock.

This work is in the hands of Mr. Robert Dahlander, director of the electrical department of the Swedish State Railways, and at a recent Congress of Swedish engineers he made public some details regarding the preliminaries to the experiments which will shortly be conducted. From Mr. Dahlander's paper we have obtained the bulk of the information herein given. The power house for the experiments is fitted with two de Laval steam turbines aggregating 350kw. and the speed of these is variable to allow of a frequency of either 25 or 15 cycles being obtained. The voltage may be stepped up by two transformers from 3000 to 20,000. About $3\frac{1}{4}$ miles of experimental track have been laid, but this will be added to as the tests proceed. The trolley wire is suspended at from 15ft. to 18ft. above the rails, and many different types of suspension have been adopted. There is the simplest form of ordinary direct suspension with trolley wire, hanger, and porcelain strain insulator. At every second pole connection is made to a conductor, insulated at the top of the bracket arm, but run through two rounded iron rings. Should the trolley wire break, the branch wire makes contact with one of the iron rings, and at once grounds the line. This suspension is arranged for both bracket and span wire. The inverted triangular arrangement of suspending the trolley from two messenger wires is also employed on the greater part of the track, though in some cases it is modified by the use of only one messenger wire. Section insulators and switches have also been erected at certain points. Wooden poles have been used throughout with the exception of six of armoured concrete on one of the curves. The track rails are used as a return, but for experimental purposes no bonds have been used.

Two types of locomotive and one motor car are to be tested during the experiments. One of the former is illustrated in Fig. 1, and is fitted with motors on the Westinghouse system. As will be seen, it is somewhat short in design, and has only four wheels. It is equipped with two 150h.p. one-phase series motors geared up in the usual way to the driving wheels. Complete with its equipment the locomotive weighs 25 tons and with a 70 ton train has been proved to attain a speed of 40 miles per hour without undue tempera

ture rise on the part of the motors. The transforming equipment has been designed for a trolley voltage of 18,000, this necessitating the use of oil-cooled transformers and oil circuit breakers and controlling apparatus. The electro-pneumatic system of control has been fitted and two locomotives can be coupled together and operated from a master controller in the front one. The illustration depicts the locomotive without buffers or connecting device, as these were to be fitted by the purchasers.

Fig. 2 illustrates the Siemens Schuckert locomotive, which has three wheel axles, each driven by a 100h.p. one-phase series motor. Two sets of gear wheels can be used with ratios of 1 to 5.13 and 1 to 3 respectively, representing speeds of 28 and 48 miles per hour. This locomotive weighs 32 tons, or with ballast 36 tons, and the wheel base has a length of 13ft. A special design of contact device has been introduced, and the transformer winding can be connected for voltages between 5000 and 20,000. A fan has been adopted for cooling the motors and it is expected that this will greatly add to their overload capacity.

The motor cars have been built by a Stockholm firm and the electrical apparatus supplied and installed by the A.E.G. of Berlin. Two Eichberg-Winter one-phase motors, each of 120h.p. capacity, are fitted one on each truck, and speeds of 28 and 40 miles per hour are expected to be obtained. The motors have two pairs of brushes, one being short circuited, and the other connected to a regulation transformer supplying current at different voltages for various speeds. This arrangement, though dispensing with a transformer for the main current, limits the voltage with which it is possible to feed the apparatus. The multiple unit system has been adopted with master controllers at each end of the car. All high tension apparatus is contained in a special chamber to which access can only be had when the contact device has been withdrawn from the wire.

We shall await the publication of official tests of these interesting railway devices with some anxiety as we think it is high time that some attempt was made by an independent authority to prove the value on a large scale of the types of one-phase railway apparatus now emanating from the chief electrical factories of the world. In this country we have not anything like the same facilities as are presented every day in a land like Sweden for turning great natural resources to such good account as the operation of railways. True it is that in the matter of main lines, volume of traffic, and high speeds, the Swedish railways do not directly compare with the great systems of this country or the Continent. Still, considerable value must attach to the result of these experiments, and the railway world at large should unite in congratulating Swedish engineers on their zeal and enterprise and in wishing them every success in their venture.

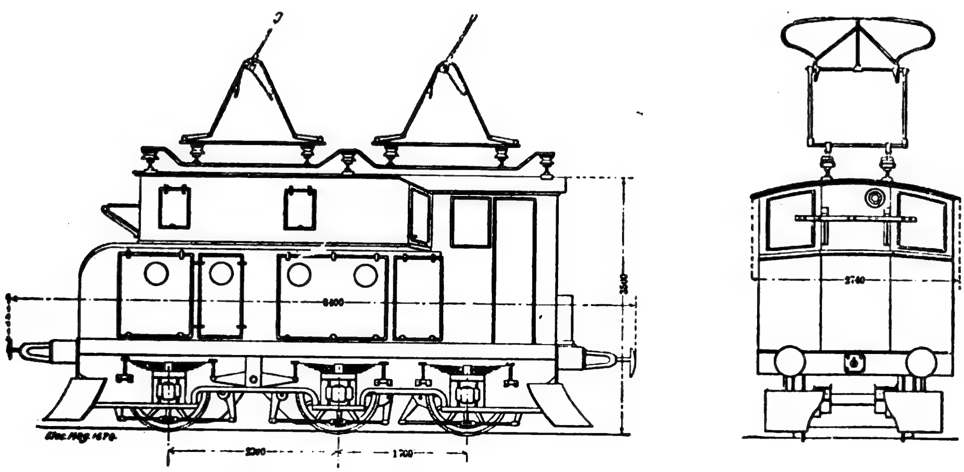


FIG 2.—ANOTHER TYPE OF ONE PHASE LOCOMOTIVE FOR SWEDISH GOVERNMENT TRIALS.

Booming Three-Phase Traction.

THE next year or two will prove whether electric railway engineers are really indebted to Ganz and Co., Budapesth, for their pioneer work with polyphase traction. Before the next twelve months have elapsed there should be something more to go upon in electric railroading than talk and doubtful figures. As this year closes the field is fairly evenly divided between direct current, one-phase, and three-phase in the matter of long lines equipped and undergoing experimental operation. But the outstanding feature of the contest is the predominance of the last two over the first in the favour of those assuming control of heavy electric traction affairs. We have already dwelt upon the invasion of America by Ganz and Co., and have referred to the campaign they have inaugurated there, doubtless with the express intention of capturing contracts for some of the long-distance lines likely to be electrified at no distant date. This is a decidedly astute move on the part of the company, as its efforts to find recognition in Europe have met with but scant encouragement outside Italy. Its British operations are now entrusted to a Scotch firm, who will shortly open the first polyphase line in these islands in North Wales. Whether the results of this lilliputian effort will be drawn upon to bring about the conversion of some important main line remains to be seen, but greater interest certainly attaches to the proceedings of the company's agents in New York. It may not be long before the recent announcement of the New York New Haven Co.'s bold bid for one-phase traction may be eclipsed by some even more startling début of polyphase methods among the third-railers and one-phasers.

After all is said and done we are not well adapted for electric railway experiments in this country. Our main lines, when compared with the prairie and desert stretches of the States, seem too congested and tortuous to be suitable for extended trials, and not until the thing is really thrust upon us shall we seriously consider the withdrawal of steam. Meantime American and Continental engineers will have done the experimenting, and if we are still adherents of the open door policy at that time we shall be harried by importunate electric railroaders to accept this system or that as running in the known parts of the civilized world.

But to return to Ganz and Co. in the city of skyscrapers. That they have started business there with serious intent and not for the benefit of the health of either themselves or the body cosmopolite, is evidenced by the papers before societies, lectures, and articles in the technical Press which from time to time appear. All this is, of course, perfectly legitimate, and is only what Americans have done in this and doubtless other countries. It is recognised by the polyphase pioneers that the ways of Rome must be their ways until such time as they can change the present aspect of railway affairs.

It may be well at this juncture to reiterate the arguments advanced in support of polyphase electric railroads. The foremost claim is undoubtedly that of simplicity of the motor and its accessories. There is no commutator and destructive sparking, and to a railway engineer accustomed to locomotives constructed on the simplest lines it is argued that the motor itself is stronger mechanically. This simple design is accompanied by reduced weight and further it carries with it the possibility of constructing a slow-speed motor which can either be built up on the driving axle or coupled to it by connecting rods. It is urged that the polyphase induction motor by its ability to return energy to the line allows the train to be brought to a standstill without the use of brakes. This recuperative feature is also recommended as valuable for equalising up the load on the line and station, while it also admits of the generating plant and feeders being reduced in size when first laid down. Where a great number of trains is in service, the fly-wheel effect which they produce in the system is even more marked, and is claimed as a strong reason for the employment of the system. The efficiency of the largest polyphase locomotives constructed has been set at 95 per cent. and this, it is claimed, can be constantly maintained.

Against these advantages the advocates of other systems state that the starting losses are very great, that speed control is only possible with complicated concatenated motors, that the motor air gap is perilously small, and that two overhead wires must be used with the collecting equipment. The cascading of the motors and the two overhead wires are apparently the chief objections commonly raised against the system. The rheostat losses

are stated to be balanced by the recuperation at stopping, so that deficiences in that respect may be disregarded.

We certainly think that some difficulty will be experienced in pushing polyphase traction into the front of electric railroading, because tampering with the speed characteristic of the induction motor appears crude on the face of it—it is like trying to make a man walk on wheels—and whatever may be said to the contrary, the second overhead wire will not find favour. The very argument advanced by the three-phasers—that the one-phase system would never be tolerated but for the single overhead wire which accompanies it—reacts upon them, as it emphasises the convictions of railway engineers that only one wire can be permitted over the track. If they will go to the drastic lengths attributed to their support of one-phase systems to attain this object, they are unlikely to be moved by the blandishments of the three-phase advocates. If recuperation must be a part of main-line electric traction it can be obtained by some motor generator system like the Ward-Leonard, which has everything to commend it to railway engineers for general adoption.

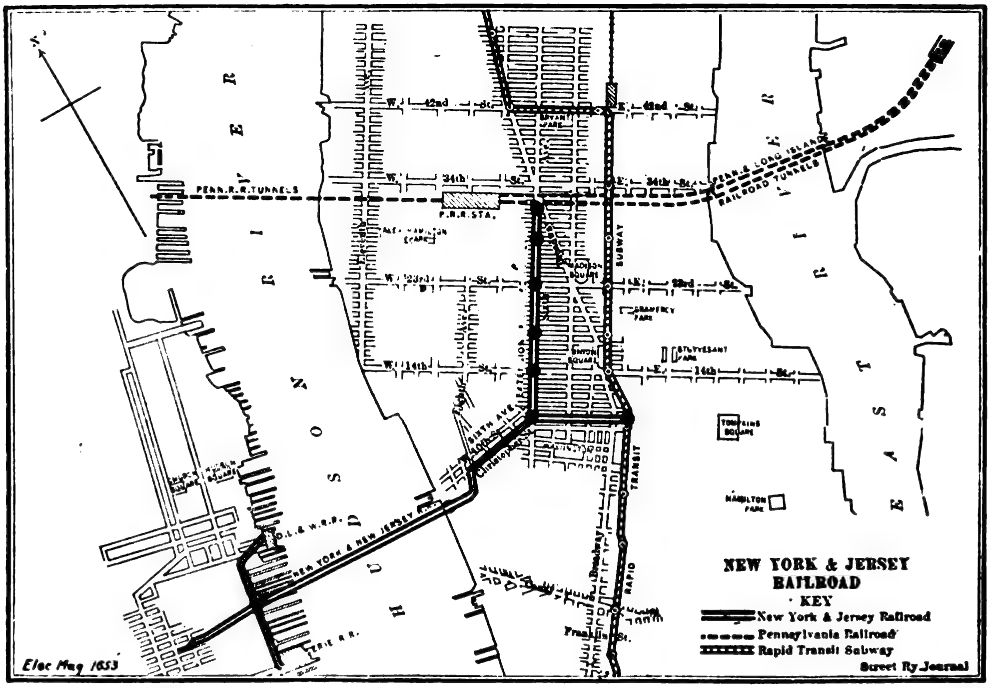
A British One-Phase Railway Motor?

The invitation to tender for the equipment with one-phase railway apparatus of a portion of the London, Brighton, and South Coast Railway near London raised our hopes that the essentially British electrical firms would come forward with some striking departure from current practice in this province. British electrical engineers have done nothing very extraordinary in railway work (though we do not infer that their confrères abroad have done much better), consequently the opportunity afforded by the enterprise of the railway in question gave them a chance to retrieve their lost laurels. The bulk of the concerns in this country which exploit one-phase railway apparatus are not handling anything conceived, designed, and built here. They have all systems coming from America or the Continent, although the actual manufacture is proceeding within the United Kingdom.

At the moment of closing for press we understand that the railway company above-mentioned after almost accepting the tender of a German firm has referred the matter back to a sub-committee for further deliberation. This news at once dashes our hopes of something fresh from the *real* Britishers in one-phase motors and equipment. True it is that the seemingly possible designs of one-phase series motors are exhausted in the types now claiming various adherents in different parts of the world. The very fact, however, that these types had been built, that data had appeared concerning them, and that they had been put into actual service, encouraged our belief that some improvement might be evolved by a British designer steering a middle course through the disadvantages of all other forms.

We have, regretfully, to record that to-day there is no British one-phase railway motor, and that an important contract for the first of our one-phase lines is likely to go to a continental concern. We are casting no aspersions on the capabilities of this particular system when we say that the work could be done equally well by a wholly British firm. Why has the subject been so sadly neglected, we wonder? There are two possibly correct answers to this query. Either the firms in question have been too busy to experiment with apparatus of this class, or they regard the production of a one-phase railway-motor as a problem quite unworthy of their efforts. Some very nasty things have been said about one-phase series motors since they were first made, and may be the British firms alluded to heartily endorse these sentiments, though they seem to do so only by their reticence in dealing with the matter.

The contention may be that in protected countries experiments can be carried out and lines equipped with greater ease than in a land such as ours, living under open-door conditions. This need not, however, deter the construction of such apparatus; indeed, it should act rather as a stimulus to our inventive genius to produce something which, despite the freedom of our imports, should enable us to meet all comers from protected lands. In the case of the London, Brighton, and South Coast proposals, we should certainly make some effort to prove that one-phase traction is a matter in which we take an active interest, and, despite the exploitation of "dumped" systems in our midst, can show that as far as the design and



PLAN OF THE TUNNELS NOW COMPLETED UNDER THE HUDSON RIVER INTO NEW YORK.
In driving these tunnels the Greathead shield method has been employed. Electric locomotives only will ply in the tunnels.

construction of such apparatus is concerned, we are equally as capable of bringing them to a successful issue as others with more immediate experience at their disposal.

Tunnelling into New York.

We have referred recently to the work of constructing a tunnel for conveying heavy freight and passenger trains between the island upon which New York stands and the mainland. On Sept. 29, the double tube tunnel system of the New York and New Jersey Railway Company under the Hudson River was completed. According to the *Street Railway Journal* the event was made the occasion of considerable ceremony. A number of officials and invited guests were present at the breaking through of the wall. Mr. W. G. Oakman, President of the Hudson Companies, himself operated the hydraulic jacks which forced the final passage through the obstructing mould and thereby permitted the party to make the first complete trip through the tube. The length of the tunnels between the shafts at Fifteen Street, Jersey City, and Morton Street, New York, is 5780ft., and the interior of each tube is 17ft. 3in. The tubes are laid almost parallel, and are only separated towards the middle of the river by about 50ft. It will be noticed from the adjoining map reproduced by permission from our contemporary that there is no cross communication between the tubes at any point between the shore shafts. In the middle of the river the tubes are 15ft. below the bed, the depth of the water at this point being about 65ft. There is a single track through each tube and the northern tube will carry the western traffic and the southern the eastern or New York traffic. The shield and hydraulic jack method, similar to that adopted by Greathead in driving the Blackwall tunnel, has been used throughout. It will be noticed that the system extends into the heart of New York City, and connects both with the Rapid Transit Subways and the system of the Pennsylvania Railroad Company.

Readers are referred to the World's Electrical Literature Section for titles of all important articles of the month relating to Lighting and Heating.

Theatre Lighting on Modern Lines.

AN installation involving some new and rather radical features in the electrical equipment of theatres has recently been made in the new theatre which has been erected on the site of the old Court Street Theatre in Buffalo, N.Y. Owing to the great amount of illumination desired, and the fact that the space at the command of the owners would not allow of the installation of a private power plant, the question of the system to be used became of paramount importance, the necessity of preserving a balance under all the diverse conditions of this kind of an equipment being thoroughly comprehended. The illuminating company impresses on its commercial lines a potential of 110-220 volts and usually requires a three-wire system. It was finally decided to place the whole installation on a two-wire system, using the 220 volt lines of the company, thus eliminating any question of balance under all conditions. For the accommodation of travelling companies, which invariably carry 110 volt appliances, a subsidiary 110 volt line was run to a duplicate set of bunch pockets located on the stage.

There are over 1,500-32c.p. lamps used on the stage alone; six borders of 200 each, 200 in the "foots," and a row round the sides and top of the proscenium arch. Those round the proscenium arch are sunk in the arch itself, behind the stucco, and are not visible to the audience. They are installed in such a manner that the light from each side is reflected clear to the front of the stage, on a line with the "foots." It seems to be a desire with some theatre people, monologists especially, to get as close to their audiences as possible, and these proscenium lights were installed especially to maintain a volume of light on the artist, under these circumstances, a spot or flood light not being acceptable.

Considering the large number of lights in the borders, the question of weight was of moment. The borders are shown in the accompanying drawing (Fig 1.) They are made wholly of medium gauzed galvanised iron, black painted outside, and of heavy white enamel inside. The receptacles are bolted to the bottom of the metal trough, the heads of bolts being sealed in, and the nuts soldered on. All the circuit wiring is laid in the metal trough, and ready accessibility in case of trouble is obtained by the removable sectional cover. A new feature

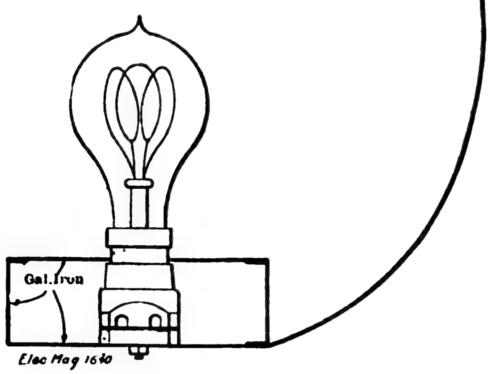


Fig. 1. Section through Lighting Border.

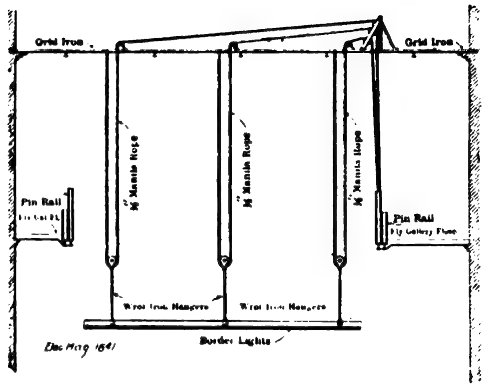


FIG. 2. METHOD OF HANGING BORDER LIGHTS.

is the hanging of the borders as shown in Fig. 2. Six-foot iron rods are riveted to the iron ribs of borders, four to each border. The borders are hung with double lines, fastened securely at gridiron, passing through small pulleys at top of iron rods, thence through sheaves and trimming blocks to a pin rail.

By a glance at the drawing as shown in Fig. 3, the best effect possible will be seen to have been attained in the footlights. A is the drip slot, B is the hinged cover to wiring trough, and C is the hinged reflector that can be thrown back to permit of changing the lamps. The incandescent part of the lamp filament is on an exact line with the floor of the stage, and by the use of the hinged parabolic reflector an even light is diffused from the floor of the stage to a considerable height. The stage switchboard is built in a solid box of concrete, access to which is gained by a small iron door at the rear. The front is protected by a heavy grille. Space was a factor, the board being allowed only 7ft. by 4ft. Every light in the building, except those in the lobby, is controlled from this board. The lobby is on a separate service, and there is not a panel board in the house. Owing to the limited amount of space and the heavy equipment, the engineer was confronted with a serious problem. All the switches are fused (the enclosed type being used) on the face of the board, there being absolutely nothing behind the board except bare copper bars. Instead of the alternate blades of switches being of the same polarity, as is usually the case, the blades most closely adjacent in separate switches are of one polarity. The fuses are installed on each side of switches instead of at the bottom.

Fuses with specially constructed terminals have to be used, so small is the available space. The 1,500 amp. fuses on the main switch are mounted one on top of another. All the switches are provided with knob handles of special design, which are placed at right angles to the cross-bars of switches. This is another space-saving arrangement and is specially adapted to quick work by the operator. At the bottom of the various rows is placed an insulated bar which prevents the switch from coming in contact with the one directly underneath, and holds the switch at right angles to the board.

The bus bars on the back of the board are welded at all bends and angles, no screws or bolts being used, and are so arranged as to be adjustable, *i.e.*, one of several special switches can be easily arranged to control any given set or combination of lights. The dimmers, which are of the "simplicity" interlocking type, are directly under the switchboard, and, in point of capacity, are the largest bank ever made by the Cutler-Hammer Company. Each exit and fire escape light is on a separate circuit, which is carried directly to the service side of the main cut-out underneath the street. These circuits, which are not fused, are controlled by a special switch located in a cabinet in the box office, which is locked when performance begins and only opened in order to throw the switches when the house is cleared. The exterior illumination is confined principally to a highly ornate porte-cochère that covers the entire side-walk. This porte-cochère is constructed almost entirely of heavy copper and stained glass, and a myriad of small lamps are ensconced in the tracery of the copper work. Over the copper-tiled roof of the porte-cochère is an ornamental double electric sign, bearing the legend "Park Theatre" in 36in. letters.

The sign is built wholly of heavy galvanised and wrought iron. Edison-base lamps are used, and the screw receptacle shells are

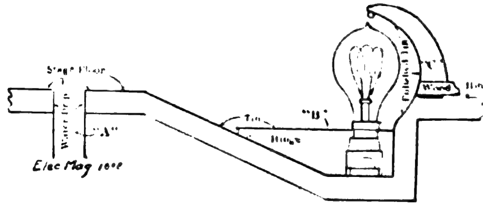


FIG. 3. THE ARRANGEMENT OF THE FOOTLIGHTS.

soldered directly to the interi r iron frame of the sign. Copper bars are run to the centre contact points of the receptacle shells, and the iron framework of the sign carries the return current. The total installation represents over 5,000 lights, and probably is the largest in this country, outside of New York City.

We are indebted to the *Electrical World*, of New York, for the above illustrations and particulars.

Notes on Reflectors and Shades.

In our last issue we entered a plea for the illuminating engineer. We can now give substantial evidence of the value of such an addition to the profession. The relative difference between shaded and unshaded lamps is not fully appreciated and it is only by the aid of diagrams that it can be clearly explained. Actual tests with lamps count for something, but when results are graphically put down on paper they enable the true merits of the case to be realised much better in actual practice. In a recent issue of the *Electrical World* Messrs. Cravath and Lansingh dealt with the matter of reflectors, shades and globes, and from their article, which is the first of the series, we have taken the adjoining illustrations. Fig. 1 depicts an unshaded bare incandescent lamp and shows the distribution of light around it. It will be noticed that the maximum candle power is on or about a horizontal plane, consequently the wall of a room would receive the maximum of light from such an illuminant, a very considerable amount also is projected towards the ceiling. In certain instances this kind of light is desirable, such as in small shops where goods are either

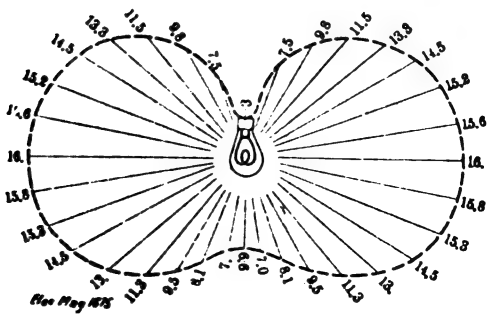


Fig. 1. Lighting Effect of Plain Unshaded Lamp.

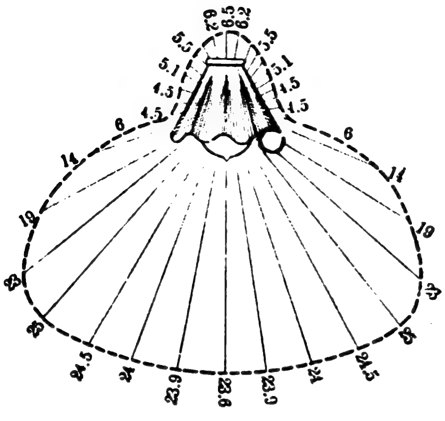


Fig. 2. Illumination from Lamp with Simple Coned Opal Reflector.

hung up on racks or stored on shelves, while they are also displayed on a counter. With a similar lamp frosted by the acid etching process almost exactly the same distribution was obtained, but in this case the actual amount of light was reduced by 11.5 per cent. As in the previous case so also with this one, the reduction of light may prove to be a desirable feature, as with a frosted bulb the rays of light being better diffused do not fall directly on the eye. A plain bulb produces a glare which tends to prevent clear vision, but a frosted globe in giving a softer and more subdued light enables one to see better.

Fig. 2 clearly indicates the advantage derived from the use of an opal cone reflector, such a reflector being very commonly used with electric lamps. In this case the useful light is mostly thrown downwards, from 23 to 25c.p. being obtained at an angle below 45° from the horizontal. The greater the density of the opal shade the more light is reflected downwards. In Fig. 3 the maximum of downward illumination is obtained, the reflector in this case being of the enamelled iron type, painted white inside. This is very largely used in workshops, drawing and business offices. The shade being opaque, no light is thrown upwards above its edges. The authors take serious objection to this particular type of shade on account of the extremely streaked light which it casts when used with a plain bulb lamp. They have found that painting the inside with aluminium paint tends to increase the diffusion, while the inversion of a frosted

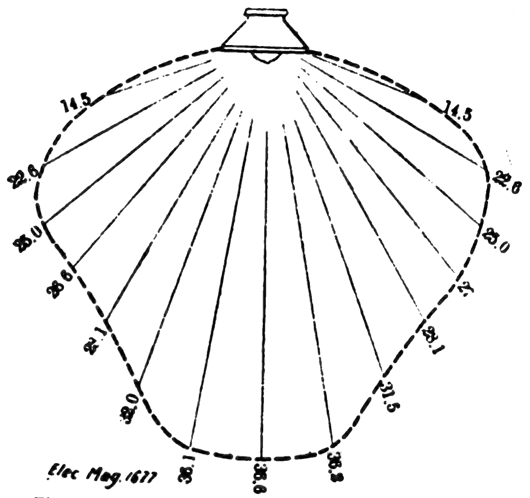


FIG. 3. LIGHT DISTRIBUTION FROM LAMP WITH OPAQUE ENAMELLED IRON SHADE.

bulb has a somewhat similar effect. The use of aluminium paint has not yet been made the subject of tests, but it is hoped later to furnish valuable data regarding it.

The above instances give some slight idea of the aspect of electric lighting which the illuminating engineer would give up his time to. Matters of this kind cannot be made the subject of investigation by lamp makers or central station engineers, and on this account the need for an independent testing authority arises. We shall be pleased to hear from any electrical engineer who is or intends qualifying for a position of this character, and those who are making the study of the application of electric lamps on scientific and methodical lines have our heartiest wishes for their success.

Light Absorption by Globes.

It has commonly been held that the addition of any form of globe to an electric lamp occasioned an abnormal absorption of its light. The actual amount of light lost in this way has been variously attributed at anything up to 30 per cent. of the total light. In a recent issue of the *Electrician*, Mr. M. Solomon published figures clearly proving the enormity of such statements. His tests were conducted with Nernst lamps. The adjoining tables contain interesting figures comparing the candle power in various positions of lamps with no globes and different types of globes. In tables 1 and 3 it will be noticed that the use of a globe tends to increase the amount of light. In the 1 ampere lamp, for instance, the mean spherical candle-power increases from 81 to 82, or a little over 1 per cent., while an increase of 3½ per cent. was obtained with the quarter ampere lamp. This peculiarity is attributed to the warming effect of the globe on the glower which is shielded from the cooling action of air currents. This, of course, somewhat discounts the value of the experiment on the light-absorbing properties of the globes, although it has yet to be shown that a similar effect is not produced with other artificial illuminants. The author stated, however, that making due allowance for this effect the high absorption figures commonly accepted were still unwarranted.

TABLE I.

Nernst Lamp. Model A. 200 Volts. 0·96 Ampere.

—	No globe.	Clear globe.	Frosted globe.	Holophane. Class A.	Holophane. Class B.
Mean horizontal candle-power	109·5	113·5	95·5	57	91·5
Candle-power vertically downwards	20·0	13·5	44·5	177	91·5
Mean hemispherical c.p. (upper)	77·0	78·0	74·5	50	41·0
Mean hemispherical c.p. (lower)	85·0	86·0	82·5	96	100·0
Mean spherical candle-power	81·0	82·0	78·5	73	70·5

TABLE II.

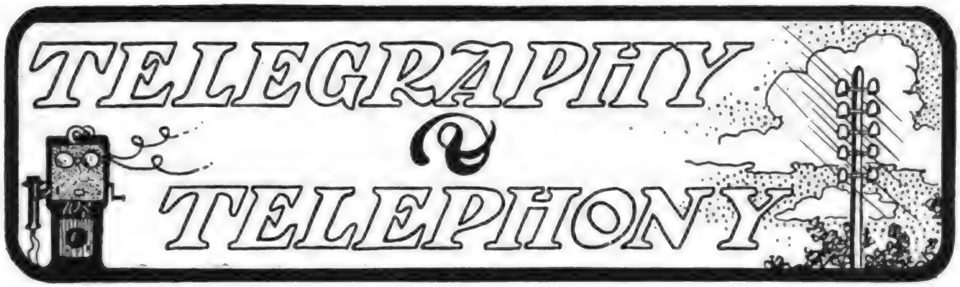
Nernst Lamp. Model A. 200 Volts. 0·52 Ampere.

—	Clear globe.	18 cm. frosted globe.	15 cm. frosted globe.
Mean horizontal candle-power	68·0	60·0	58·5
Candle-power vertically downwards	7·5	31·0	25·0
Mean hemispherical c.p. (upper)	43·5	42·5	46·5
Mean hemispherical c.p. (lower)	53·5	54·5	50·5
Mean spherical candle-power	48·5	48·5	48·5

TABLE III.

Nernst Lamp. Model B. 200 Volts. 0·24 Ampere.

—	No globe.	Clear globe.	Frosted globe.
Mean horizontal candle-power	12·0	13·0	13·1
Maximum horizontal candle-power	19·8	20·0	17·4
Minimum horizontal candle-power	1·7	2·2	6·6
Candle-power vertically downwards	24·0	23·8	24·3
Mean hemispherical c.p. (upper)	9·0	9·3	9·2
Mean hemispherical c.p. (lower)	17·8	18·5	18·2
Mean spherical candle-power	13·4	13·9	13·7

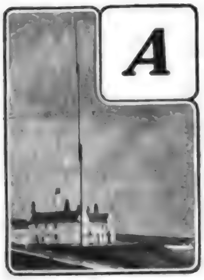


For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section.

Magnetic Detectors of Electric Waves.

By L. H. WALTER, M.A., A.M.Inst.C.E.

[*The first part of this article appeared in* Technics *for August, but owing to the publication of this magazine being discontinued the writer has to express his thanks to the proprietors of* THE ELECTRICAL MAGAZINE *for publishing this second and concluding part.*]



ANOTHER quantitive detector has been devised by Huth. In this a Rutherford solenoidal detector is suspended in the earth's field, and, when the core is magnetised, it orients itself so that the couple due to the twisted suspension balances that due to the magnetic action. On oscillations arriving, the demagnetisation of the core causes it to take up a new position, the deflection being read off on a scale. When oscillations acted upon the detector whilst the magnetising current was on, a small deflection in the opposite direction, due to an increase of induction, was noticed.

The next detector to appear, in 1903, is due to Fleming. This is a combination of the Rutherford solenoidal detector with the method proposed by Wilson—of having several cores, so that one is always in the most sensitive condition.

Fig. 9 shows one form of the instrument as constructed by Buscemi for experimental purposes. The instrument is made up of a number of elemental detectors, one of which is shown in the small diagram at the bottom of Fig. 9, each element comprising a Rutherford core, a demagnetising coil, $c\ c^1$ with an auxiliary magnetising coil, $a\ a^1$; the magnetising coils are in series, the demagnetising ones in parallel; these are all placed inside a larger coil (shown wound in six sections) for detecting the change in magnetisation. This detector possesses several advantages over the Wilson detector. The E.M.F.'s set up in the observation coils by the action of oscillations are all in the same direction, being due to a demagnetising action; consequently a galvanometer can be used in the place of a telephone, enabling quantitative results to be obtained. The magnetisation of the cores and the sequence of contact-making is effected by a rotating contact-maker C 1, 2, 3, 4, 5, the cores being first magnetised from the battery P through $a_1^1\ a_1\ s_1$ 1-5 s_5, while the galvanometer coil is short circuited through $S_2\ S_4$; the short circuit is then opened, and the galvanometer coil

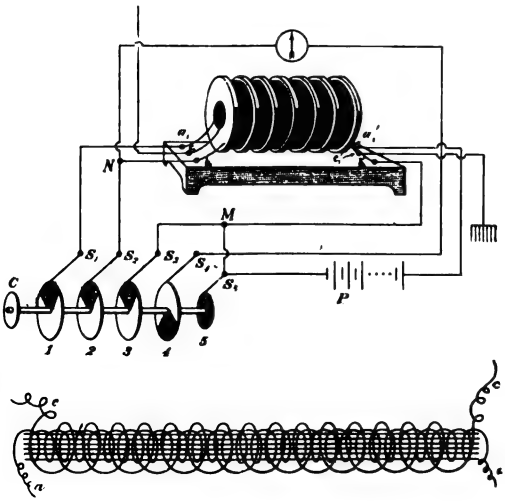


FIG. 9

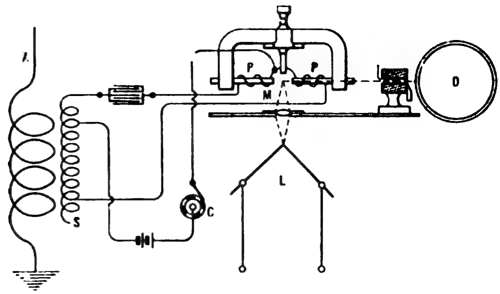


FIG. 10.

b_1 b_1^1 connected up to the galvanometer from b^1 through NGS_4 45 S_5 Mb_1^1. On the sequence of operations being carried out rapidly enough, the intermittent unidirectional impulses resulting from the oscillations arriving produce a steady deflection on the galvanometer.

A quite recent detector is that devised by King, and described in connection with his wireless telegraphic system. This detector is a type of oscillograph utilising the differentially-balanced method of Wilson, but instead of using the disturbance of the balance to affect a receiver electrically, this is caused to affect a suspended magnet-and-mirror system, M, placed between the poles, PP, of a permanent magnet (Fig. 10).

An alternating current produced by means of the rotating commutator C, is passed round the poles PP of the magnet, but has no effect on the suspended system until oscillations arrive and disturb the balance. The deflections are recorded photographically on the drum D by the aid of the arc lamp L. It is too early to speak with certainty as to the capabilities of this detector, but the photographic recording is a complication.

The remaining instruments are mostly variations in detail, and depend for their working on one or other of the principles already described.

Thus, Tissot has designed two forms of Marconi detector. One of these consists of two identical cyclic-flux detectors, A, B (Fig. 11), where the telephone coils *a b* are opposed to one another, so that the slow variations in flux due to the varying field are balanced, and there is normally silence in the telephone, or no deflection on the galvanometer G (Fig. 11). B alone is provided with a winding for the oscillations. Incidentally this arrangement allows the field cycle to be completed more rapidly, and the insensitive point is therefore less noticeable. The second form consists in an adaptation of the Marconi moving-band form in the shape of a Gramme ring, which is provided with a coil for the oscillations, and one for the telephone, connection to these being made by means of four slip-rings—one each to earth and aerial, and two to the telephone terminals.

Tissot found that steel gave better results than iron in the core. He considers the

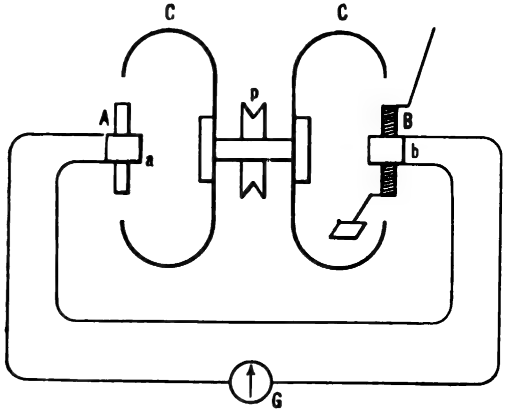


FIG. 11.

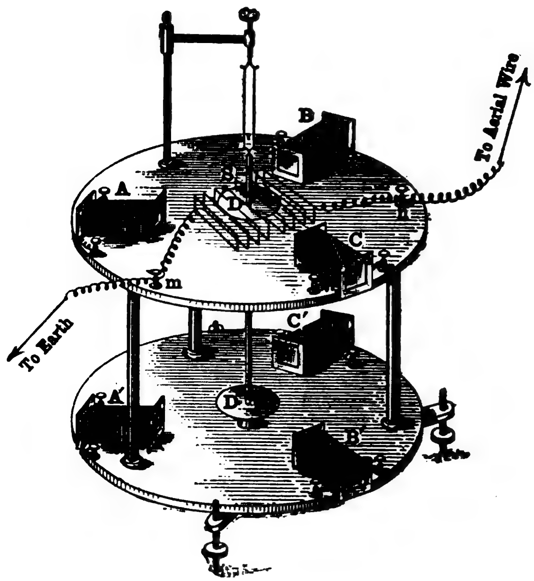


FIG. 12.
(By Permission of " The Electrician.")

effect to be due to an actual decrease of hysteresis, as opposed to Marconi's view that only the time-lag is decreased.

Arnò has brought out a form of Walter-Ewing detector, in which the change in hysteresis loss in the steel discs D D^1, produced when oscillations are led through the coil S, is directly measured, two oppositely-rotating fields, produced by three-phase currents supplied to the magnets ABC and $A^1B^1C^1$, being made use of (Fig. 12).

Peukert has also made use of the same principle; his apparatus can readily be understood by reference to Fig. 13, where E, E is the pivoted core, and A, B is the rotating magnet, the winding on E E being connected to antenna and earth in the usual way by means of slip-rings; the deflection of the magnet A B directly actuates the relay tongue Z.

Reich has recently devised another application of the Rutherford principle in combination with the Poulsen telegraphone method, by means similar to that used by Shoemaker. A moving magnetised steel wire, similar to that used in the telegraphone, is surrounded by a demagnetising winding connected to the aerial and earth respectively. The effect of oscillations produced by signals is to demagnetise the wire just under the winding, more or less according to the strength and duration of the signals, so that on passing the wire in front of a telegraphonic reproducer the minute local changes of magnetism reproduce the signals in the telephone.

DeForest has modified the Marconi cyclic-flux detector by making the core C in the form of a hollow shell, and placing so-

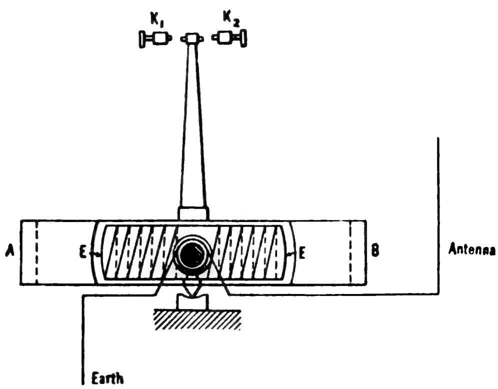


Fig. 13.

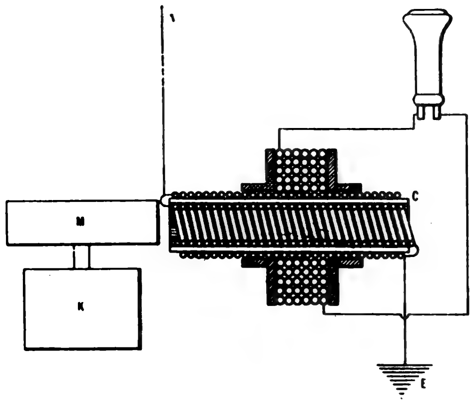


Fig. 14.

called demagnetising (?) coils both inside and outside the core, in the aerial circuit A E (Fig. 14). M is the rotating magnet driven by clockwork K, producing the varying field. Troy proposes to use iron filings in place of solid iron as a core in the Marconi cyclic-flux detector, the varying field being produced by an alternating current of very low frequency.

It is impossible to conclude the list of detectors without referring to that of Sella, although it does not strictly belong to the magnetic type. Sella found that when an iron or steel wire is subjected to a cyclic torsional stress, it is sensitive to the action of electric waves, as in the analogous case of a wire subjected to a magnetic cycle. He has devised an instrument depending upon the variation of magneto-elastic hysteresis, which can be used as a detector of electric waves; its sensibility is probably not very great.

Magnetic detectors as a class have several important advantages. The chief among these are:—

1. That they are current-operated devices, which do not respond to minute direct currents such as are set up by atmospheric disturbances.

2. They can be used within a few feet even of a transmitter for physical or measurement purposes.

3. They possess a low and constant resistance, so that tuning adjustments are facilitated.

4. They are exceedingly sensitive, without the drawbacks of sensitive potential-operated

devices, and are well adapted for syntonic operation.

5. Various forms of such detectors are well suited for quantitative work.

It may be pointed out that magnetic detectors have latterly become of increasing importance, in part owing to the good results obtained by Marconi with his instrument, and also to the fact that the recent decision in the United States, in the matter of the Marconi "basic" patent, has apparently rendered the combination of a coherer (or an electrolytic detector) with the simple Marconi aerial, no longer a public property as of yore.

Within the last twelve months or so a considerable amount of discussion has also taken place as to the effect of electrical oscillations in detectors depending upon the hysteresis principle; but the correctness of the writer's early results now appears to be generally conceded, that the hysteresis loss is increased in weak fields and decreased in much stronger fields; from which it follows that there is an insensitive point somewhere between these two. The hysteresis lag is, in general, diminished in the weaker fields, but it is not yet definitely known what part, if any, of the diminished hysteresis loss in the stronger fields is due to decrease of induction, manifesting itself as an increase of hysteretic lag. In conclusion, it may be said that all magnetic detectors owe their origin to Rutherford's brilliant discovery —a fact which is not sufficiently borne in mind at the present time. The advances made have, as before indicated, been chiefly in the means of rendering the action automatic (as regards remagnetisation) and in improvements in observing the magnetic changes produced. The sensitiveness is stated to have been greatly increased, but this is not conceded in some quarters. It seems safe, on the whole, to assume that a greater sensitiveness to very weak forces is possessed by those instruments which use iron of less coercive force in place of steel; but the sensitiveness is obtained with a corresponding sacrifice of volume of sound where the reception is telephonic. The use of steel allows of a much greater change for the same volume of metal. By increasing the amount of iron, the volume of sound can be increased, but the limit of core diameter ($<\frac{1}{5}$ inch) is soon reached, above which the oscillations do not sufficiently affect the interior portions of the core, as was found by Fleming in the case of his quantitative detector. If the oscillations are passed through the magnetic material itself this limit does not exist, but there is here again a well-marked best value; if the oscillatory current is further subdivided by employing a larger number of wires in parallel, little advantage is obtained from the greater volume of metal. As in many other cases, the best design is a compromise best adapted to the particular conditions under which the detector is to be used.

A word might be said as to Marconi's latest development—the actuation of a relay by the minute currents set up in the signal coil of a magnetic detector, thus enabling messages to be recorded.

On hearing of this improvement the writer realised that such a result was not to be expected from the actual Marconi detector, as the currents set up in the signal coil are not unidirectional. By making use of the Rutherford demagnetising effect alone it should, however, be quite practicable by simple means. The precise means which Marconi employs have not yet been made public, beyond that a special iron (more retentive (?)) must be used, and that a greater volume of iron in the core is necessary, to slow down the rate of the impulses; but the detector exhibited at the Royal Institution lecture confirmed the writer in his views, for the magnet (only one to each coil O O, Fig. 4, in first part) was placed so that the flux through the core did not embrace the signal coil, C, but was placed clear of OO and C, thus reverting to the Rutherford construction of Shoemaker (Fig. 4a), and no longer employing the true Marconi effect. As regards the larger quantity of iron: the core was made thicker, and four demagnetising windings, each with signal coil, were placed at different parts of the core. But other means may have also been employed, as there was a sealed box, the function of which was not explained. Nothing has been said as to the sensitiveness of this device; it is probably considerably less than that of the ordinary Marconi detector. It may be mentioned in this connection that the writer has recently succeeded in devising a magnetic detector on quite new lines, which will actuate a relay and consequently operate a recording instrument, besides being available for telephonic reception. This instrument requires neither of the special features found necessary in the Marconi recording detector. Further particulars will be made public in due course.

Telegraphy Correspondence Class.—IX.

Conducted by CICERONE.

It is again a pleasing experience to receive so many appreciative epistles from the students of this section, but the number who regularly and consistently answer the questions is not altogether what might be desired. It is a pity that so many take a pleasure in reading the work of others without making an attempt themselves. Only by steady application can anyone hope to succeed in the gentle art of answering questions accurately and concisely. An esteemed correspondent sends a photograph of an up-to-date cable station equipment, which is very interesting and will be valued in the prized collection of such articles. His appreciative note regarding the benefits he has derived from this section is also highly gratifying, and again we wish him every success in his manly endeavours to better his position.

In the budget of answers submitted to the six problems set in the September issue some excellent examples appear.

The first question is answered briefly and to the point by Rex in this manner: "The stresses to which an overhead telegraph line is exposed are (a) static and (b) dynamic or kinetic. The former are due to the crushing stress of the wires and mountings as well as those strains experienced on a long grade in hilly districts. These forces generally act in a longitudinal direction. The latter, *i.e.* dynamic or kinetic stresses, are felt laterally, and are due to wind pressure. Both these classes of stress are met by providing supports of proper strength, and strutting or staying the poles by means of suitable material."

Pelmar adds to an equally clear answer, "Where the line of poles is on the curve, a stay or strut is placed so as to oppose the resultant pull exercised by the wires on each side, which resultant may be found by a calculation involving the weight of the wires and the angle of curve. Kinetic stress varies according to the pressure of wind and cannot be accurately calculated beforehand, so that the question of meeting kinetic stresses is a general one, involving the strength and stability of the line as a whole.

The static stress S in foot-cwts. sustained at the base of an unstayed pole = Wd where:

W = horizontal static stress in cwts., or the strain due to all the wires.

d = the distance between the ground line and the resultant point in feet (say 20 feet).

Substituting the given values we get

$$S = Wd = 12 \times 270 \times 20 = 578 \text{ foot-cwts.}$$

To the second question the answers received are mostly correct. The weight and strain of the wires being equal, the sags d and d_1 will vary as the square of the respective lengths $\frac{d}{d_1} = \frac{60^2}{100^2}$ or as 9 : 25.

Taking the weight per foot as equal, the strain will vary directly as the square of the lengths and inversely as the sags, or

$$\frac{S}{S_1} = \frac{l^2 d_1}{l^2_1 d} = \frac{80^2 \times 10}{120^2 \times 5} = \frac{8}{9} \text{ or as } 8:9.$$

The first half of the third question has been solved correctly by all the competitors. The stress on an 80yds. span of 400lbs. wire having a dip of 2ft. = S.

$$S = \frac{l^2 w}{8d}$$

where $l = 80 \times 3 = 240$ft.

$$w = \frac{400}{5280} = \frac{5}{66} \text{lbs. per foot}$$

and d = 2 feet.

Substituting these values,

$$S = \frac{240^2 \times 5}{8 \times 2 \times 66} = 272\text{lbs. nearly.}$$

By an increase of sag to 3ft., the length of wire in the span will be increased from $l + \frac{8 \times 2^2}{3 \times l}$ to $l + \frac{8 \times 3^2}{3 \times l}$. Substituting the given values we get the length of wire per span = L and L_1.

$$L = 240 + \frac{8 \times 2^2}{3 \times 240} = 240\tfrac{2}{45}\text{ft.}$$

$$\text{and } L_1 = 240 + \frac{8 \times 3^2}{3 \times 240} = 240\tfrac{1}{10}\text{ft.}$$

$\therefore$ Increase per span $= 240\frac{1}{10} - 240\frac{2}{45} = \frac{1}{18}$ft. or .055ft.

The breaking strain of a wire is proportional to its sectional area, or the square of its diameter.

$\therefore$ For two wires of the same metal but diameters of 2 to 1 the breaking strains will be as $2^2 : 1^2$, or as in Question 4. Strain $= \frac{1^2}{2^2}$ of 1250, or $\frac{1}{4}$ of 1250 = 312.5lbs.

The breaking weight W of the same class of timber varies with the section.

For square timber $W = BD^2 = D^3$

But $D = 2R$ where R = radius

$\therefore D^3 = 8R^3$

For round timber $W = 4.7R^3$ and

For octagonal timber $W = 4.14R^3$.

Question 5 is solved from formula $L = l \times \frac{8d^2}{3l}$ which gives the length of wire in one span.

From values given

$$L = 240 + \frac{8 \times 1^2}{3 \times 240} = 240\tfrac{1}{90}\text{ft.}$$

Number of spans per mile $= \frac{1760}{80} = 22$

$\therefore$ Total length of wire required for one mile $= 5180 + 22 \times \frac{1}{90} = 5280.24$ft. $= 1760.08$yds. $= 1$ mile 3 inches.

The increase in length of the wire with a rise of 5° Fahr. will be found from the formula:

$$d_1 = \sqrt{d^2 + l^2 (t \times \tfrac{3}{8}k)}$$

d_1 being the dip at the higher temperature $= \sqrt{1^2 + 240^2 (5 \times .375 \times .00000956)} = 1.426$ft.

With this dip $L = l + \frac{8 \times 1.426^2}{3 \times 240} = 240.02254$.

Deducting the previous value of L ($240\frac{1}{90}$ft.) we get an increase of .01ft. per span of 80yds.

Treyar has had a struggle over this question, but has ultimately obtained a pretty accurate result.

The horizontal stress s_1 due to lateral wind pressure $= s_1 = s \times l \times \frac{2}{3}d \times n$

s = pressure per square foot,
where l = length of span,
d = diameter of wire (say .158),
n = number of wires.

Substituting values

$$s_1 = \frac{20 \times 1760 \times \frac{2}{3} \times .158 \times 36}{144} = 927\text{lbs. nearly.}$$

Treyar reasons it out thus:—Assuming the wire to be 400lbs. (*i.e.*, 158 mils. diameter) the number of square feet it contains =

$$\frac{1760 \times 36 \times 0.158}{144} = 69.52,$$

But the effective area is only two-thirds of this.

$$\therefore 69.52 \times \tfrac{2}{3} = 46.346.$$

The wind pressure is 20lbs. for every square foot.

$$\therefore 46.346 \times 20 = 926.92\text{lbs.}$$

The final problem has been correctly solved by all competitors.

Length of stay $= \sqrt{24^2 + 10^2} = 26$ft.

Let x = strain on stay,

Then $10 : 26 :: 4500 : x$

and $x = \frac{26 \times 4500}{10}$lbs. $= 104$cwts.

Forest Telephones.

A TRAVELLER treading the forests of northern Maine, particularly that heavily wooded section lying north and east of Moosehead Lake and extending to and along the west branch of the Penobscot river, will be struck with wonder when he sees the extent to which the march of progress has left its tracks in the shape of the telephone.

Useful as the telephone is in the city, where the steps it saves would in any case be made easy by the use of the automobile, electric or fast express, it is far more useful in the forest, where there are none of these conveniences, and where the canoe or bateau is the common vehicle of travel. The manner in which the telephone is used to help the men who drive the logs is perhaps the greatest feature of the whole system. The dams along the west branch have been built not only to hold water against a time of drought, but also to control the flood, so that it may let down the river at judicious times. To this end a considerable crew of men is kept at the dams all the time, so that the gates may be opened or closed on short notice.

Before dynamite came into common use on the drives, there were some great times for the river drivers along Ripogenus Gorge. Then if a jam formed it was a case of getting down on to the logs and breaking it out. A man was lowered down from the ledge above, 100ft. or more, and went out on the jam. Fastening a long line to a log he made his way back to shore. Then the crew surged on the line and pulled the logs off the jam until the key log could be cut or broken.

Before the telephone came into use these messages were conveyed up the river by relays of men. The men were stationed at frequent intervals along the bank, and the message was shouted from man to man. The telephone lines are being extended every year, and it will not be long before telephones are almost as common in the woods as they are in the city. Considering the country through which the men doing the work have to travel, the lines are put up in remarkably quick time, for a small crew of men will put up many miles of wire in a week. The lines spoken of in this article are not the only ones in the Moosehead, and connect many of the sporting camps about the lake; they also run up the North Branch of the Penobscot.

Recently the telephone has been called into use to aid the fire wardens in discovering and extinguishing fires in the northern forests. A station has been established on the summit of Squaw Mountain, about six miles west of Greenville. A man stationed at this point can see the country for miles around, and with the aid of powerful field glasses and range finders can discover and locate a fire within range of sixty miles in any direction.

ELECTRO-CHEMISTRY, Electro-Physics and ELECTRO-METALLURGY

Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section.

*Copper and the Electrolytic Refining Industry.**

By JOHN B. C. KERSHAW.

THE copper production of the world in 1904 amounted to the enormous total of 613,000 tons, according to the recently published statistical table compiled by Messrs. H. R. Merton and Co. To this total the mines o the United States contributed no less than 334,000 tons, or over 54 per cent.

The increase of production during the last eleven years has been most striking; but, as shown by the figures in the following table, the rate of increase has been somewhat irregular year by year, being lowest in 1895 and 1900, and highest in the years 1896, 1899, and 1904, respectively.

Year.	Output.	Average Price.	Year.	Output.	Average Price.
1894....	324,000	£40⅛	1900....	479,000	£73½
1895....	334,000	42⅞	1901....	516,000	68
1896....	373,000	47¼	1902....	541,000	52⅝
1897....	399,000	49½	1903....	574,000	57⅞
1898....	429,000	51⅜	1904....	613,000	58¾
1899....	472,000	72¾			

During these eleven years the production of the United States has grown from 159,000 tons to 334,000 tons, the mines in Arizona having chiefly contributed to this increase. The copper mines of the United States are now, in fact, producing more copper than all the mines of the world produced eleven years ago, and, moreover, are still rapidly increasing their output. On the other hand, the older copper mines of Germany, Spain, and Portugal have not added to their aggregate output during the same period; on the contrary, as regards the mines located in the two latter countries, there is a tendency for the production to diminish. The increase, however, is not confined to North America. For example, Australia increased her output from 9000 to 34,000 tons in eleven years: Canada from 5000 to 19,000 tons; Chili from 21,000 to 30,000 tons; Japan from 20,000 to 34,000 tons; and Mexico from 12,000 to 51,000 tons. Judged by percentages, the last country has increased its production to a greater extent than the United States or any of its rivals, and it is noteworthy that this development has occurred chiefly in connection with the reworking of old mines.

The enormous expansion of the copper-mining industry during the last eleven years is chiefly due to the great demand for this metal in the electrical engineering and allied trades. Copper ranks next to silver as an electrical conductor, and its electrical conductivity depends greatly upon its purity. Hence the demand for copper refined by the electrolytic process, its purity being much higher than that refined only by the ordinary metallurgical method. In fact, in 1903 it was estimated that over 324,000 tons of copper, or nearly 57 per cent. of the total output, was refined by the electrolytic process.

Electrolytic copper refining is the largest as well as the oldest of the electro-metallurgical industries, and in view of the fact that the greatest refineries are now found across the Atlantic, it is noteworthy that the industry originated in the United Kingdom, being founded by one of the Elkington Brothers at Pembrey, South Wales, in the year 1869. Charles Watt, in his remarkable patent No. 13,755, of 1851 (the master patent of the electro-chemical and electro-metallurgical industries) was the first to point out that crude metals could be purified in the electrolytic cell by making them function as anode in a suitable electrolyte, in which the

* From the Engineering Supplement of the London *Times*.

impurities could not dissolve. Watt was many years too early with his patent, and until the direct-current dynamo had been invented and much improved, no industrial development of Watt's ideas was possible. In the year 1865, however, James Elkington, of the famous Birmingham firm of electro-platers, commenced experimental work upon these lines, which resulted in two patents being applied for in that year and in 1869, and in the latter year a small factory for operating the refining process was erected at Pembrey, near Swansea, South Wales. The output at this factory in the early days was only 1500 pounds of refined copper per 24 hours, or about 250 tons per annum. Cylindrical earthenware vessels, 33in. high by 17in. in diameter, were used as depositing cells and each contained four cathodes and six anodes. They were placed terracewise in order to obtain circulation of the electrolyte, and 100 of them were connected in series. A saturated copper sulphate solution functioned as the electrolyte. This experimental plant at Pembrey proved so successful that the plant was soon enlarged to a capacity of 1000 tons per annum. This oldest electrolytic refinery in the world is still in existence, although it has passed into the hands of another firm — Messrs. Elliots' Metal Company of Birmingham.

As regards the principle of the electrolytic method of copper refining, it is simply an extension, on an enormously magnified scale of operations, of one of the earliest experiments carried out by the student of electricity in the physical-science laboratory. The decomposition of a solution of copper sulphate by means of the electric current, and the deposition of copper at the cathode, using pure copper-foil electrodes, is an old and well-known laboratory experiment and is the basis of the electrotyping industry. When this experiment is carried out with impure copper as anode material, and with a slightly acid solution of copper sulphate as electrolyte, the conditions obtaining in the refining works are exactly reproduced. It will be seen that the impurities of the copper do not dissolve, but collect on the face of the anode, and finally fall to the bottom of the beaker or vessel in which the experiment is made. The copper alone dissolves at the anode, and is redeposited at the cathode, while the impurities collect as the insoluble "anode slime," or mud. If we possessed eyes capable of penetrating the molecular structure of the clear blue copper solution contained in the glass jar during the experiment, we might expect to see a regular and continuous drift of myriads of the most minute particles of copper from the piece which was being dissolved toward the other; and if we possessed means of isolating one of these particles, and of testing it, we should find that it carried an extremely infinitesimal charge of electricity. When we realize that this transfer of copper from the one piece to the other is taking place atom by atom, and it is calculated that there are sixty thousand million million of atoms in one cubic inch, it may seem incredible that this method of producing pure copper should be used on a scale of operations for industrial purposes.

The electrolytic production of copper, however, not only exists as an industry, but, as already pointed out, is one that in recent years has attained very great magnitude. In the period 1870-1890, the growth of the electrolytic copper-refining industry was slow, and the refineries erected in this country, Germany, France, and America were all of small size. The second refinery in the United Kingdom was that of Messrs. Bolton and Sons, followed by the erection of three plants at Swansea, about 1880, for Messrs. William Foster and Co., Messrs. Vivians and Messrs. Lambert, respectively. Since 1891, however, the industry has undergone enormous expansion, chiefly in America. According to Ulke, the statistician of the industry, there are 32 refineries in operation at the present date, with an annual output of 324,000 tons. America contributes nine refineries and 86 per cent. of this total. The English refineries are six in number, and are stated by the same authority to be producing 8.8 per cent. of the 324,000 tons, or 28,500 tons per annum. Reliable figures on this subject are, however, difficult to obtain since for many years past the English refiners have refused to publish any details concerning their works or output, and Ulke's figures are simply estimates based on expert knowledge.

The transfer of the chief centre of the electrolytic copper-refining industry to the other side of the Atlantic from England and Germany, where it originally developed, has been brought about by comparatively simple causes. The electrolytic process of refining copper is most successfully worked with metals from pyretic ores, carrying considerable amounts of silver and gold. When such

crude metal is treated by the electrolytic process, the silver and gold collect on the bottom of the baths as "anode slimes" or mud. The value of the precious metals recovered from the slimes produced, when refining certain classes of ore, pays many times over for the cost of the refining process, and it is these ores which are chiefly found in the butte districts of the western mining states of Montana and California. Twenty years ago these ores were only smelted in America, and the crude metal was shipped to England, France, and Germany, for the refining operation. To-day this position of affairs is changed. America no longer exports the crude copper containing silver and gold as impurities; she extracts these metals by the electrolytic refining process, either at the mines, as at Anaconda, or at one of the smelting and refining works erected in the eastern states, and exports only refined copper to Europe. English, German, and French works have thus been deprived of their most valuable source of metal for the electrolytic refining operation, and the development of the industry on this side of the Atlantic has consequently been checked by causes beyond the control of the owners of the refineries. For this reason none of the electrolytic copper refineries in England are comparable in size and output to those found across the Atlantic, and much difficulty is experienced by their owners in obtaining a supply of crude metal even for the much smaller scale upon which they are operating.

Problems of Electro and Electro-Thermal Chemistry.*

By R. THRELFALL, F.R.S.

THE position of a chemical manufacturer when called upon for a presidential address is not a particularly happy one. Reticence is a tradition of the chemical industry, and the introduction of processes based on electro-chemical operations has, if anything, increased the habit of, as well as the necessity for, uncommunicativeness. It is hoped that this remark may serve as my excuse for adopting a distant standpoint in the brief survey I propose to make of some electro-chemical matters.

* Abstract from Inaugural Address to the Birmingham Section of the Institution of Electrical Engineers. Delivered November 22, 1905.

The general condition of the industry is the topic which naturally presents itself as of greatest interest. In the early nineties of the last century there is no doubt that very extravagant ideas were current as to the part which electricity was to play in the chemical industries. The early anticipations have not been altogether realised, and it is now pretty clearly seen that there are many processes in which the intervention of electricity is not commercially advantageous even though it may be technically practicable.

Possibly an illustration may be the direct fixation of the nitrogen of the air in the form of oxides by some form of electric discharge. The chief difficulty here is that Nature has long ago fixed a great deal of nitrogen in the nitre beds of Chile, and at present it is cheaper to dig up the fixed nitrogen and to carry it to where it is required than it is to fix it electrically at some point nearer to the centre of consumption. The electric process, however, is no doubt susceptible of improvement, and apparently occupies the minds of a good many inventors. The shortest cut to a successful result will probably be found in a thorough study of the theory of the reaction. The yield of oxides (for all the oxides of nitrogen appear to be formed) depends on the nature of the spark or electric flame, on the shape of the containing vessel, and velocity of the air stream among other factors, and it may well be years before the conditions for best working are clearly set forth.

In their French patent No. 335,692, Eyde and Birksland claim to be able to make as much as 650 kilos of oxydised nitrogen (calculated as nitric acid) for one kilowatt year. On the basis of power at Niagara price (nominally $20 per E.H.P. year) I find that 1lb. of (mostly potential) nitric acid would cost about 0.9d., while if $10 power be considered the standard, the cost for power would be naturally 0.45d. With Chile saltpetre at 10s. 6d. per cwt. at Liverpool, the value of the nitric acid content could be put at about 1.17d. per pound HNO_3. The air oxidation workers would, however, require to neutralise the product for manureal purposes presumably with limestone, the cost of which is inappreciable in a rough calculation, though the labour and packing of the nitrate and nitrite mixture probably is not. There is no information available as to the other items of manufacturing cost, but it looks as if there was a possibility of an industry in this direction with a $10 power

in an agricultural country. If I were working at this problem, I think I should try the effect of a discharge in an atmosphere carrying a lime-water fog in suspension and in rapid motion.

Some years ago (*Phil. Mag.*, 1893, p. 27) I noticed that mercury and nitrogen can be made to combine by an electric discharge at about 0.8mm. pressure, and not too high a temperature—say, under 200°C. It might be worth while to examine whether mercury vapour, air and steam at, say, 160°C., where the vapour tension of mercury is 5.9mm., could be made to yield ammonia, if not oxide of nitrogen: the mercury could possibly be recovered; if it could not its use would impracticable. Meanwhile, the researches of Caro and Frank seemed to have reached a practical stage in the commercial production of cyanamide with the electric furnace. So far as I understand the matter, calcium carbide was originally treated at about 2000°C. with nitrogen—giving calcium cyanamide. At a later date the cyanamide was to be produced in the same furnace as the carbide, though, so far as I know, details have not been published. According to Dr. Frank (*Zeitschrift für Elektrochemie*, Vol. IX., p. 858, 1903) calcium cyanamide can be used direct as an artificial manure.

It was originally proposed to use cyanamide as the basis of a process for making potassium or sodium cyanide, but so far as is known to me, this idea has been given up, cyanide of the very high quality now required by consumers being more easily produced in other ways.

The whole subject of the fixation of nitrogen is of the greatest interest to mankind—of greater interest than any other chemical problem; but whether the fixation can be best done by electricity or in other ways—by bacteria, for instance—is a question which time alone can decide.

The world's consumption of ammonia and nitrate in 1903 amounted, according to Dr. Frank, to between eighteen and nineteen million pounds sterling: not a very large sum having regard to the greatness of the agricultural industry. I look forward to the time when, through the labours of chemists, the price of fixed nitrogen shall have dropped to something like one-tenth of its present value, and the consumption be limited mainly by the cost of distribution.

Carbon has long been an object of interest from another point of view—*viz.*, from that of making a battery in which carbon is the soluble electrode. We might in this way get more mechanical work per ton of coal than we get by burning the coal under boilers. Many attempts have been made to realise such a battery, and I presume that unless we regard the gas battery of Mond and Langer as a solution we should consider the attempt of Jacques as the one most nearly approaching technical requirements. If we make use of electrodes of iron and carbon in molten sodium hydroxide, the carbon behaves as a soluble electrode, and the P.D. of the cell is of the order of about 1 volt. It has, however, been lately shown that the cell works on the principle of a gas battery under the influence of the oxygen of the air on the one hand and of the reaction between carbon and melted caustic giving hydrogen on the carbon surface on the other. A trace of manganese in the soda makes the process permanent by acting as a substance oxidisable by air and reducible by hydrogen. It is clear, therefore, that the Jacques apparatus brings us no nearer the solution of the question, Can carbon act as the soluble electrode, and if not, why not?

In considering the possibility of a carbon cell it is clear that there are two difficulties. The power of forming a soluble electrode may be confined to those substances we know as metals, or it may be that the difficulty consists in finding a suitable electrolyte—a difficulty, in fact, which has not yet been overcome. It occurred to me that perhaps a gaseous electrolyte might serve. For instance, we might consider such a combination as carbon-ionised oxygen-gold, the oxygen being ionised, say, by radium. In this case the positive ions might be taken by the carbon and the negative ions (electrons) would possibly disappear on the gold electrode. If this were a possible phenomenon (and I am unable to see why it should not be), we should have the current running from carbon to gold outside the cell. It would be a simple experiment for any one having a little radium, though Prof. J. J. Thomson tells me the current would be infinitesimal (supposing one was formed) below a red heat—at which temperature there would be ordinary combustion. An interesting variation would be to try phosgene gas between electrodes of carbon and iron, say.

(*To be concluded.*)

Every aspect of the design and manufacture of electrical apparatus will be dealt with in this section month by month, and Engineers connected with large manufacturing concerns are especially invited to contribute.

Notes on Switchgear Controlling Apparatus.

By CHARLES C. GARRARD, Ph.D., A.M.I.E.E.

(Concluded from p. 301.)

A DISADVANTAGE which could be urged against relays constructed on the induction principle is that their calibration is dependent on the frequency; thus a 50 period relay would be practically useless if the periodicity fell to 25. Against this it may be said that such an alteration in frequency never occurs in practice. It can only be the result of the generators slowing down with consequent reduction of the supply voltage. Of course small variations in the periodicity, say of 5 per cent. or 10 per cent., alter slightly the calibration, but this does not matter. In order to obviate this effect of change of frequency, the relays may be compensated by means of a non-inductive shunt. Such a compensation is often made in the case of induction ammeters, but as yet it has not been considered necessary to apply it to relays.

In such a compensated instrument we have two circuits—an inductive and a non-inductive—in parallel, Fig. 4.

In the diagram, Fig. 5, if OV represent the voltage drop across the instrument terminals, we get

$C_1 = \frac{V}{r_1}$ where r_1 = resistance of non-inductive shunt.

$C_2 = \frac{V}{pL}$ where L = self-induction of the electro-magnet winding, the ohmic resistance of which is neglected, and $p = 2\pi \times$ frequency.

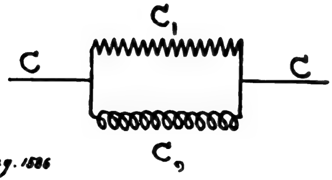


Fig. 4.

If C = total current through the relay, we get

$$C = \sqrt{C_1^2 + C_2^2} = \frac{V}{r_1 pL}\sqrt{p^2L^2 + r_1^2}$$

$$\frac{C_2}{C} = \frac{1}{\sqrt{\frac{p^2L^2}{r_1^2} + 1}},$$ *i.e.*, the smaller the frequency the larger the proportion of the main current flowing through the electro-magnet, thus compensating for the smaller driving force due to the lower periodicity.

A type of maximum current time limit relay depending on the electro-magnetic solenoid principle is the ingenious arrangement of a double fluid dashpot recently invented by Mr. Leonard Andrews. A somewhat similar idea to this was a dashpot time limit arrangement got out by the writer (*see*

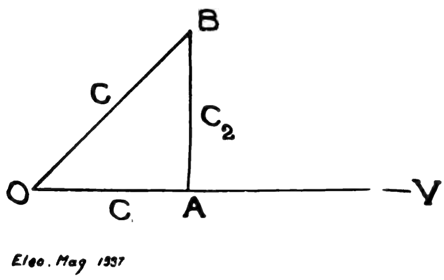


Fig. 5.

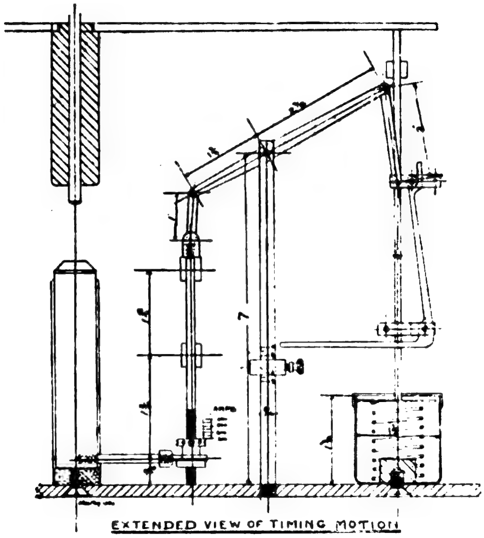


FIG. 6.

Fig. 6) some years ago, in which it was attempted to attach the dashpot piston directly to the solenoid plunger which operated the switch, *i.e.*, to dispense with the relay altogether. This arrangement, however, was not used much as it was found that the relay device was a better one.

An electro-magnetic maximum time limit relay constructed without the use of dashpots which has several advantages above other types is illustrated diagrammatically in Fig. 7.

It consists of an electro-magnet, E, fed from a current transformer, CT, in the controlled circuit. The armature, A, can be set to be drawn up at any predetermined current by the screw and scale, G. The armature, A, normally shorts the contacts, C, and thus no current flows through the heating coil, W, until the predetermined overload is reached. When this current is exceeded, however, the current is caused to flow round the heating coil, W, warming the air in the right hand bulb of the pair of bulbs, B. Due to the expansion of the air in the bulb, the mercury in the U tube is forced along until contact is made between the platinum contacts, TT, which close the switch tripping coil circuit. The time taken for the mercury to flow along the U tube is inversely proportional to the extent of the overload. The object of the second pair of contacts, D, is to remove the sparking due to the rupture of the trip coil circuit from inside the glass bulb. The chief merits of this design are that both the point at which the apparatus shall work and the time element can be set very easily. Also the trip coil current can be broken in the relay, rendering a separate contactor on the main switch unnecessary. Its disadvantage is that it is not quite instantaneous in action for very big overloads. This is got over by making the electro-magnet, E, with two armatures, the second one of which is held back with a much stronger spring than the other. With a very big overload, therefore, this second armature is drawn up instantaneously, and is so arranged that in doing so it closes the trip coil circuit directly, thus instantly opening the controlled circuit breaker.

(B) *Reverse Current Relays for Alternating Currents.*

To many people the idea of a "reverse" alternating current is a little difficult of comprehension; a somewhat elementary exposition of the subject may therefore be excused.

We will first of all consider the phase relationships of the current, and we will take as reference the bus bar voltage. The current we are considering is the current flowing in the cable which connects the alternator to the bus bar. Other generators are supposed to be feeding this bus bar and running in parallel with the said generator. For simplicity single phase machines are assumed. The normal condition of things is represented

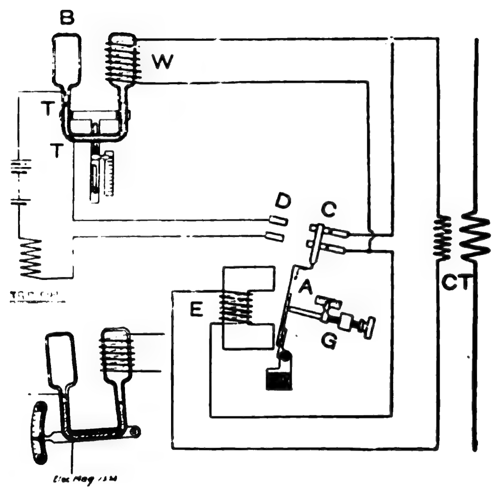


FIG. 7.

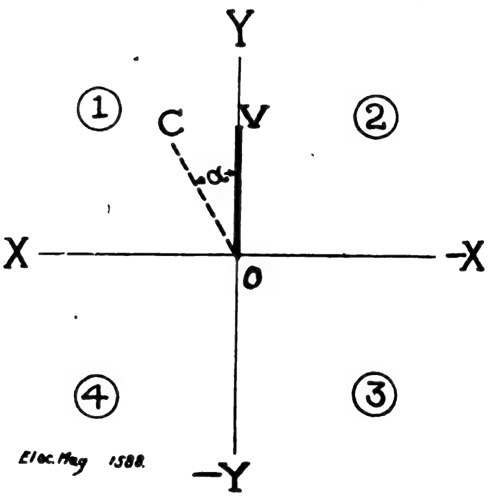


Fig. 8.

in Fig. 8, where OV is the bus bar voltage and OC the current in the said cable, *i.e.*, the current lags behind the BB voltage by α degrees. Now the size of the angle α depends on two things—

(*a*) The induction of the load.
(*b*) The excitation of the generators.

Considering (*a*) for itself, it is clear that the line OC, representing the current, may lie anywhere within the quadrant (1), bounded by OY and OX. Power factors as low as .3 are sometimes obtained, which represents an angle of lag of 72°, *i.e.*, the current vector almost coincides with OX. All this time the generator is in perfect order, and supplying energy to the bus bars. Thus an alternating reverse current relay should not operate while the current vector is in quadrant (1).

Now consider quadrant (2); current here is leading, which may be due to—

(*c*) Capacity in the load.
(*d*) Excitation of the generators.

Considering (*c*) first, a large system is known to the writer where, at least within the last year or two, the load during a large part of the day had a power factor of about .3, the current leading, this being due to the large electrostatic capacity of the cables and the light load. Thus we see that under quite normal conditions the current vector may almost coincide with the line O—X, the generator acting quite normally, and supplying energy to the circuits. It follows that an alternating reverse current relay should not operate when the current vector is in quadrant (2).

In the above we have left out of consideration the fact that the current vector may be caused to move about over the quadrants (1) and (2) by varying the excitation of the alternators. Thus the excitation of the generator in question may be reduced, but at the same time the supply of steam to the prime mover may be kept up. In order that the generator should keep on pumping energy into the system it is necessary for its terminal voltage to be maintained. This the generator does automatically by allowing a leading current to flow into it (cross current), which makes up for the deficient exciting current by its armature reaction or magnetising effect. Thus, although the load may be inductive, we may have a leading current in the conductor in question, the relations being shown in Fig. 9.

It may now be urged, with some show of reason, that if the excitation current be so reduced that the angle of lead exceeds a certain value an alternating reverse relay ought to operate. But this is a fallacy. As we have already shown, an ordinary leading current due to capacity in the load may cause the current to lead by very big angles. Under these circumstances nobody would suggest, of course, that the relay should

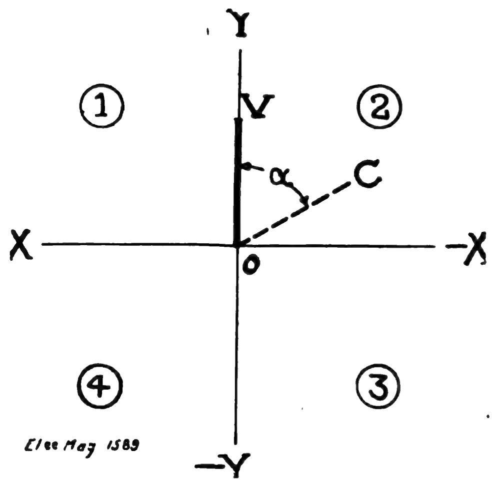


Fig. 9.

operate. It therefore comes to this: that the relay is called upon to discriminate between a leading current due to capacity in the load and leading current due to the relative values of the exciting currents of the several generators. This is clearly an impossibility. A second scheme would be to fix upon a certain angle of lead as the maximum which it is possible to obtain due to capacity in the load. But this is very difficult as the conditions of the load can never be reckoned upon as constant. Also it must be remembered that the actuating force in the relay is proportional to the current flowing through it, and therefore the particular angle of lead at which it will operate will vary with the current. Such a state of things is clearly inadmissible. A third alternative is to alter the adjustment of the relay to suit the varying conditions of load. This would entail one or two scientific assistants sitting on the switchboard with an oscillograph or so, making observations all day. We are afraid that the thereby introduced increase in the running costs of the station would prevent any station manager putting such a system in operation.

The conclusion to be drawn from all this is that an alternating reverse relay should not operate with the current vector in either of the two quadrants (1) and (2).

We now have to consider the quadrants (3) and (4), Fig. 10.

In the whole of this argument we have, of course, assumed that the generator remains in

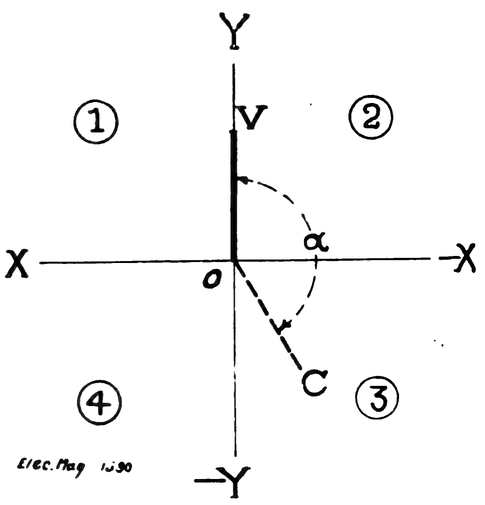


Fig. 10.

step no matter in what position the current vector may come relatively to the voltage vector OV. The first thing that strikes us in considering the state of things with the current vector in the quadrants (3) and (4) is that, whereas, while it was in the quadrants (1) and (2) the generator was pumping electrical energy into the system beyond the bus bars, the bus bars are now pumping energy into the alternator, which is being driven as a motor. The alternator clearly has ceased to perform its proper function and should be disconnected from the bars. Current in the quadrant (3) corresponds to the machine running as an under-excited synchronous motor and is the condition of things obtained when the steam fails with a low exciting current; and the current vector may be *anywhere* in the quadrant (3) depending on the circumstances of the case. Current in the quadrant (4) corresponds to the machine running as an over-excited motor, a condition of things which would obtain if the steam were to fail just when the generator was adjusted to give a large lagging current for an inductive load, or to make up for deficient excitation in the other machines with which the one we are considering is running in parallel. The current vector may likewise be *anywhere* in the quadrant (4), depending on the circumstances.

We therefore arrive at the conclusion that the alternating reverse cut-out should operate when the current vector is in quadrants (3) or (4), but not when it is in the quadrants (1) or (2). A device which will do this is, of course, simply a wattmeter, and we arrive at the important conclusion that the principle on which the alternating reverse device is to be constructed must be the wattmeter principle, *i.e.*, *when*, and *not till*, the flow of power in the conductors leading from the machine to the bus bars reverses in direction, the apparatus should work.

If anybody has difficulty in seeing why the device, which will operate under the above set forth conditions, is a wattmeter, the difficulty may be removed by considering that the actuating force in the relay is proportional to the r.m.s. value of the voltage, multiplied by the r.m s. value of the current, multiplied by the cosine of the angle of phase difference between the voltage and the current. The r.m.s. values of voltage and current remain positive, as does cosine α so long as the current vector remains in quadrants (1) and (2). Directly it gets,

however, into (3) and (4) cosine α becomes negative.

The simplest apparatus which can be utilised on the above enunciated principle is a wattmeter, provided with a pair of contacts arranged to close the tripping coil circuit when the meter runs backwards. A wattmeter is, however, not the only apparatus which may be used without departing from the underlying principle. Thus a power factor indicator could be applied arranged to close the tripping coil circuit directly the lag or lead between volts and amperes exceeded 90°. This would have the added advantage that the functioning of the relay would be independent to a great extent of the magnitude of the voltage and current.

Most practical alternating reverse relays which have been used have consisted simply of wattmeters, and their proper designation is "reverse power relays," and the author would suggest the retention of this name instead of the vague term "alternating reverse current relays."

One important aspect of this question remains yet to be considered. This is as follows: Something happens to the excitation or steam supply of the generator, and it falls out of step. What occurs then, provided the machine be equipped with a reverse power protective device?

Firstly.—The steam supply fails; there will be now no energy pumped from the machine into the bus bars; but energy will be forced from the BB's into the machine, and will be dissipated in C^2R losses in the winding and magnetising (hysteresis), and eddy current losses in the iron of the machine. We have to determine how large the current will be which will flow into the generator. It is clear that if we neglect the hysteresis and eddy current losses, and assume that all the energy of the current will be absorbed as joulian heat in the winding, we shall get a maximum value of the current. We will take it that the reverse power relay is set to operate at 10 per cent. of the full load rated output of the machine. Let us assume a copper drop of 1 per cent. in the generator, which will be about right. It follows that if the full load output be W watts and the full load current be C amperes, at C amperes the C^2r loss in the armature is $\frac{W}{100}$ watts. At a current equal to 3.15 times the full load current the C^2r loss in the generator would be equal to $\frac{W}{10}$ (as $3.15^2 = 10$); *i.e.*, with the reverse power relay set to operate at 10 per cent. of the full load of a machine having a 1 per cent. copper drop, the maximum current which can flow into the machine, assuming, of course, that the insulation has not broken down, is 3.15 times the full load current. This is a current which any modern alternator can carry for a short period without risk of burn out. As a matter of fact, it is inadmissible to neglect the iron and eddy loss, and therefore the maximum possible current will be considerably below this, and this will be yet further reduced by any diminution of the bus bar voltage. It appears therefore that a reverse power relay set for 10 per cent. reverse power affords adequate protection for a generator under the above set forth conditions.

Secondly.—The steam supply does not fail. Under these circumstances we have power flowing into the machine from the bus bars corresponding to a current of one frequency and power flowing from the machine to the bus bars corresponding to a current of another frequency. The magnitude of the former power is determined by the C^2r, hysteresis, and eddy current losses in the generator, and that of the latter by the nature of the load, it being very different if it be synchronous motors than if it be lamps. Large currents could flow through the machine and it is doubtful whether the reverse power relay would work. In fact, it is safe to assert that it is impossible to construct a single relay which would act satisfactorily under these circumstances. The only thing which might do is a maximum current device set very high and with a long time limit. It has, however, been generally considered undesirable to have maximum current circuit breakers of any kind on generators, and the idea of a maximum current relay set very high and with very long time limit, in series with the reverse power relay for the protection of generators is put forward by the writer by way of suggestion.

To conclude this article one more case may be considered, *i.e.*, a breakdown of insulation in the armature of the generator. This will be taken care of by the reverse power cut-out, as there will be a flow of power from the bars to the earthed winding, the arc which forms also absorbing the energy generated by the alternator itself.

The Design of Power Plants.

In an important number of a series of articles on "Power-Plant Design and Economics," in the *Engineering Magazine*, Mr. Franz Koester takes up the electrical equipment of the generating plant. Economy in the electrical equipment of the plant is not of such great importance as reliability of service, the former depending more closely upon the water and coal consumption in the power plant, while breakdowns are much more frequent in the electrical equipment. Modern practice seems to tend toward the general adoption of electrically driven auxiliaries, such as water and air pumps, exciter sets, &c. Individual electric-motor drive for the machinery of the boiler house has long since been recognised as the best practice, although steam engineers still cling tenaciously to steam-driven auxiliaries. This is attributed to a fear of total breakdown of the electrical machinery in spite of the fact that provision could easily be made for this. When the individual motor drive is adopted a storage battery can always be installed to supply power and thus act as standby in case of a breakdown, unless the auxiliary generator be steam-driven and the current drawn from an entirely distinct system from the main line. It is further pointed out that the presence of a storage battery in the power house is invaluable in case of a heavy short-circuit. It also assists in maintaining the voltage, and is often employed for the operation of automatic switches. With so many uses of the battery it might well be installed of sufficient capacity to supply power in case of emergency. Although the cost of installaand maintenance is great, the storage battery is usually a paying investment, depending, of course, on the type of service. In large power houses a special building at the side of the engine room for switching and measuring purposes is considered of great importance, but where space does not allow of this, part of the generating room should be allotted for this purpose only, as it is not thought to be good practice to place the switchboard near the operating side of the plant. The main bus bars may be located below the floor level of the engine room, but the controlling switches should be placed preferably in the gallery, from which the generating room is easily overlooked. A flexible wiring system and a well-arranged switchboard are of the greatest importance to ensure a steady operation of the power plant. Oil switches are commonly placed in fire-proof compartments of either brick or concrete, the front openings being closed with either slate or soapstone slabs, or, in some cases, by wired glass. The latter is said to be no more liable to rupture in case of a short-circuit than the first two. Practice in America makes the switchboard as simple and plain as possible. In Europe, in many places, much artistic effort has been given to beautify this part of the equipment, and the author thinks that this effort is not at all wasted. All tests in connection with the operation of the plant, whether satisfactory or otherwise, should, in his opinion, be reported in the technical press, to give opportunity for criticism by competent engineers, and in this we quite agree. The spirit and policy of publicity is generally characteristic of the best modern practice, whether in the construction or operation of engineering works.

A New Dynamo.

The special feature of this machine is that the magnetic flux is not perpendicular to the direction of the axle in the armature, but is essentially parallel to the axle. The iron sheets are put together in packages, each package being pressed together by two end discs. Between the different packages wedge-formed air spaces are left which are filled with the armature wire. The field magnets are arranged in pairs in such a way that their yoke is parallel to the axle. Opposite to an armature sheet there is, therefore, on one side a north pole and on the other sidea south pole. The latest types of these machines are stated to have a capacity one and a-half to twice the capacity of machines of normal construction. A motor of 50h.p. constant capacity has a maximum diameter of casing of about 720mm., its weight is 668kg., the efficiency 85 per cent., the number of revolutions 650 at 220 volts. Of the active material, the armature copper weighs 40kg., the commutator copper 46kg., and the field magnet copper 50kg.; consequently, the total weight of copper is 136kg. The armature iron weighs 170kg., the field magnet iron 225kg., hence the total weight of active iron is 395kg. The intention is to apply the same construction to alternators and induction motors, and it is expected that the latter will show a good power factor.—*Elek. Bahnen.*

The World's Electrical Literature Section contains a classified list of all articles of interest to Central Station men. CONSULT IT and save yourself much valuable time.

Increasing Profits of a Central Station.

By GEORGE E. WALSH.

THE practice of heating houses and buildings by steam or hot water has not found favour in this country, although it is practically standard in the United States and Canada. This circumstance is substantially proved by the following abstracts from an article recently contributed to the *American Electrician.* We do not expect there are many central station engineers who will be zealous enough to advise their committees to pipe the streets neighbouring the works for the profitable dispensation of the exhaust steam from their power plants. In small districts the idea may be feasible enough, and the information given below will in such cases be useful, while it also illustrates in what a keen business spirit our friends across the sea conduct the affairs of electricity supply stations.

The central station company has usually greater advantages in supplying steam for heating purposes than the independent steam plant. The electric light company has business relations with numerous customers which make it comparatively easier to present a proposition for supplying steam heat for their houses and offices. Some electric light companies which have entered this field have recently been forced to increase the size of their plant in order to meet the demands upon it, although six months ago their electric output barely paid a profit on the investment.

Steam exhausted from the engine can be economically distributed to customers for heating purposes, and the consensus of opinion among steam and electrical engineers in the district heating field is that exhaust steam should be sold on the basis of live steam. Even at the cost of producing live steam and distributing it through the mains, the price would be much lower than it would cost individuals to produce it. The cost of producing the live steam must be determined and fixed, and meter charges made accordingly.

Some central station companies can save this waste steam by simply installing the underground mains and piping the buildings of customers. In the construction of new central stations engineers are making designs with reference to this combination of lighting and heating, and in the near future nearly every electric light plant will likewise be a steam heating station for the distribution of heat to customers. The service is growing so rapidly in favour in small towns and cities that owners of old plants are studying the situation with a view to changing their machinery to secure this new source of profit.

In old plants where the engines operate as condensing units, the condensers are detached during the heating months, and during the summer months they are operated condensing. Arrangements are also made so that the engines can operate part condensing and part non-condensing. When the full amount of steam is not required the changeable nature of the plant will thus insure greater profits. In some stations where the installation of engines is not sufficient to supply all the steam needed for

Main Engine Room, Waterside Station, New York Edison Company.
This plant, comprising Eleven 5,000kw. Engine-driven Units, has been completed by the addition of Five 5,000kw. Curtis Turbines.

customers, additions to carry the load have proved profitable. That is, there is a profit in supplying steam heat alone, and where the exhaust from the electric light plant is not sufficient it is economical to increase it. The enlargement of the plant so that live steam can be supplied where the exhaust is insufficient has frequently demonstrated the economy and value of this phase of the business.

The methods of charging for steam heat supplied are various, but the meter system is the only satisfactory one both to consumers and producers. By estimating the cost of production of live steam it is possible to establish a rate that will prove profitable. By using meters the charges are automatically adjusted to the different classes of buildings. The varying demand for steam heat during the different hours of the day can soon be ascertained by the curve sheet plotted from the reading of the meters. In this way it is possible to estimate in advance the comparative demand for steam at different hours, so the use of all the engines can be regulated without waste of energy.

The People's Gas and Electric Company, of Defiance, Ohio, has a hot water circulating system installed in connection with the electric light plant with charges to consumers based upon the square feet of radiation. Nearly 2000ft. of 2in. main pipes are laid underground by this company, and upward of 2500ft. of 4in. pipe. In this plant the exhaust steam from the engine is carried to an open heater where the water is heated to 160°. An ordinary boiler feed pump is used for circulating the hot water which is distributed to houses from two to three thousand feet distant. The charges are based upon the number of square feet of radiation installed in each house, and the returns from the exhaust steam have proved very profitable.

Where the exhaust steam just equals the demand of consumers there is large profit in the work; but the periods when the exhaust steam is not sufficient must be considered. It is often necessary to run an independent

engine to supply live steam to meet the requirements on very cold days or in the early winter evenings. The electric lighting is essentially a night load, but the highest peak is reached early in the evening or late in the afternoon of winter days. This is likewise the period when the greatest demand exists for steam for heating. It is often impossible to supply the two with the engines of the central station installed simply for the lighting load. The important question is to ascertain just when the conditions will warrant the enlargement of the plant by adding an independent engine for carrying the extra load.

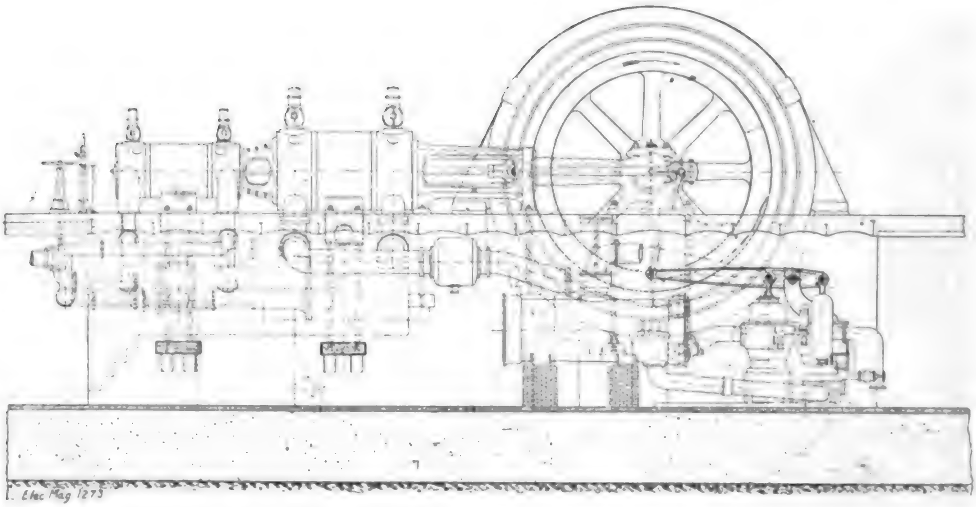
A great many electric light companies operating by water power have installed engines for distributing steam heat to the different parts of the buildings of the plant. Such engines are used at times to carry part of the electric lighting load, but as a rule the engines are not in use a good part of the year. When the plant is a large one this extra engine is found profitable, and in some cases it has been used for supplying district steam heating for other buildings in order to prevent rivals from entering the field. Where a neighbouring plant or large building installs its own steam heating plant, it is very apt to furnish its own light as well. By anticipating this the electric companies have shut off private competition in electric light.

Indeed, it looks very much as if the electric companies must come to adopting this double work, so popular is steam heating becoming. The large office buildings and plants which depend upon electric light and power consider seriously the question of operating their own electric light and heating plant. The problem is only half solved when electric light and power are sold to

Exterior of Waterside Station of New York Edison Company, showing massive proportions of the Building 80,000kw. of plant is installed and in operation.

them at a minimum of cost. The heating of the building must come up for serious attention. By supplying both electricity and steam heating to its customers, the electric light and power company gives added satisfaction and secures double returns on the investment.

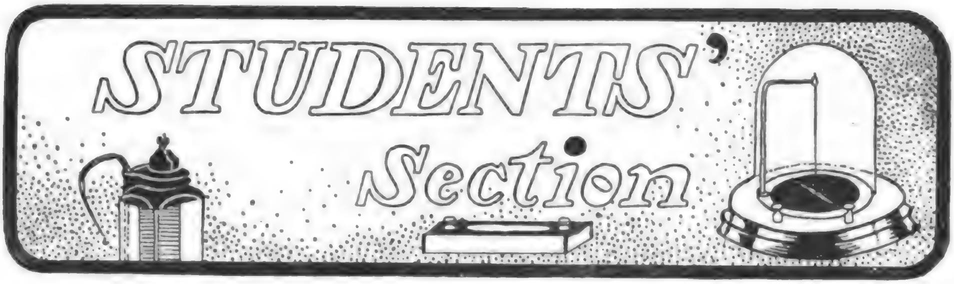
While a central station plant can earn money out of exhaust steam for heating residences and offices in winter, the question of utilising the power in the summer months has caused not a little bother and a good deal of practical experiment. With the day load in summer very light, the power of the engine should be utilised in some other economical way. A number of small central station plants supplying electric light for public and private use have in the past few years sought to extend their field by combining steam heating in winter and the operation of refrigerating and ice manufacturing plants in summer. Ice-making and artificial refrigeration are summer loads, and the steam from the boilers which are used as auxiliaries in winter can be turned to profitable use in operating ice machines in the hot months. By combining the two industries the engines need be left idle only a very little of the time. The possibilities in this direction are not so limited as they may appear. A good many cold storage plants are operated only in the warm season, usually about four to six months in the year. The work of supplying steam for distilled water and for manufacturing ice or artificial refrigeration is sometimes problematical, for the cost of live steam furnished from boilers that are left idle most of the year is very high.



A Typical Continental Horizontal Engine-driven Generator, complete with Underfloor Condensing Plant operated from the Main Cross Head.

An electric light plant in Rochester which used exhaust steam for heating residences in winter enlarged its capacity by the installation of two extra boilers which furnished live steam when the demand was unusually heavy. Ultimately it was expected that the new boilers would be needed for the electric light business as the business increased, but until needed for that purpose the boilers were employed for furnishing live steam to customers for heating. The profits of this feature of the business proved so large that it was necessary to make another addition to the plant.

The question of utilising these boilers in summer puzzled the engineers and managers for some time. The idleness a good part of the year seemed like waste. The managers tried to make arrangements to operate cold storage plants with their live steam, but owing to its peculiar location this seemed impossible. After a good deal of experiment and study it was decided to start a small ice-making plant near the central station. This was experimental, and the venture was carried on a small scale. But after one season's operation the success of the plant was evident. The ice was sold by contract to a local ice distributor, and the extra boilers were kept in profitable service all the year.



Students should refer to the World's Electrical Literature Section for classified list of articles of special interest to them.

Problems on Distributing Networks.—IX.

By ALFRED HAY, D.Sc., M.I.E.E.

(*Concluded from p. 219.*)

IN some cases it becomes possible to reduce the number of nodes in the network before writing down the equations for determining the potential drops. This may be done by the aid of an artifice devised by Dr. Kennelly, which consists in substituting a △ for a Y, or *vice versa*, in certain portions of the network. The proposition on which the procedure is based was originally published by Dr. Kennelly in the *Electrical World and Engineer* for September 19th, 1899, without any proof.

Equivalence of △ and Y in Conducting Network.

Let in Fig. 27 the triangle A B C represent a portion of a network *loaded at the nodes only*, as indicated by the arrows at A, B and C. Let us imagine that it is possible to replace the three conductors A B, B C and C A, represented by the sides of the triangle, by three others, radiating from the point O and forming a star or Y, so that the distribution of the currents in the remainder of the network remains unaltered. Then it is clear that the number of nodes will have been reduced from three (A, B and C) to one (O), and the solution of the network problem correspondingly simplified.

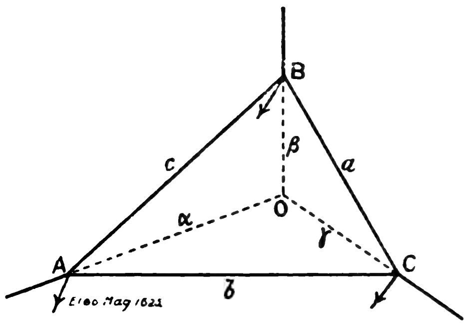


Fig. 27.

In order to enable us to use this transformation, we have to show, in the first place, that it is possible; and secondly, we have to find the values of the resistances $OA = \alpha$, $OB = \beta$, and $OC = \gamma$ in terms of the three resistances $AB = c$, $BC = a$ and $CA = b$.

Now whatever the actual distribution of currents in the sides of the △ may happen to be, we can always replace this distribution by three equivalent imaginary distributions, as follows:—In the first imaginary distribution the △ is severed from the remainder of the network at the point C—so that the current in a is the same as that in b—and there is a flow of current from A to B (or in the opposite direction) along the two parallel paths $AB = c$ and $ACB = b + a$. In the second imaginary distribution the △ is severed from the network at A, so that a flow of current now takes place from B to C (or from C to B) along the two parallel paths $BC = a$ and $BAC = c + b$. Finally, in the third imaginary distribution the △ is severed from the network at B, a current now flowing from C to A (or A to C) along the two parallel paths $CA = b$ and $CBA = a + c$.

The condition that the three imaginary distributions when superposed should be equivalent to the actual distribution is that the sum of the three imaginary currents in each side of the Δ should equal the actual current in that side. This imposes three conditions on the imaginary currents. Now there are, as a matter of fact, only three unknown quantities to be determined—viz., the *total* currents from A to B, from B to C, and from C to A, in the three imaginary distributions. For if the total current from, say, A to B is known, then by the rule for the division of a current between two parallel paths we can immediately determine the imaginary currents along those two paths. Thus there are three unknown quantities to be found, and since they are subject to three conditions, we can always find their values from the three equations which express those conditions.

We have therefore shown that the substitution of the three imaginary distributions for the actual distribution is always a possible and legitimate process. It follows that the substitution of a Y for a Δ connecting the three points A B C, is legitimate if the resistances α, β and γ can be so chosen that for each of the three imaginary distributions, the total resistance offered by the Y to the flow of current between the two points considered is the same as the resistance offered by the Δ. Since this consideration imposes three conditions on the three unknown resistances, α, β and γ, it follows that values of α, β and γ can always be found to satisfy those conditions. Thus the substitution of a Y for a Δ, or *vice versa*, is always possible without disturbing the currents in the remainder of the network.

We have next to determine the values of α, β and γ in terms of a, b and c. Considering the resistance between the points A and B in the two cases of a Y and a Δ, we see that (since the resistance must be the same in each case)—

$$\alpha+\beta=\frac{c\,(a+b)}{a+b+c} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Similarly, for the remaining two pairs of points—B and C, and C and A—we must have, respectively,

$$\beta+\gamma=\frac{a\,(b+c)}{a+b+c} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\gamma+\alpha=\frac{b\,(c+a)}{a+b+c} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Subtracting (2) from (3), we find

$$\alpha-\beta=\frac{b\,c-c\,a}{a+b+c},$$

and on adding this to (1), we get

$$\alpha=\frac{b\,c}{a+b+c} \quad . \quad . \quad . \quad . \quad (4)$$

By symmetry,

$$\beta=\frac{c\,a}{a+b+c} \quad . \quad . \quad . \quad . \quad (5)$$

$$\gamma=\frac{a\,b}{a+b+c} \quad . \quad . \quad . \quad . \quad (6)$$

If we wish to replace a Y by a Δ, it becomes necessary to express a, b, and c in terms of α, β, and γ. Dividing numerator and denominator of the right-hand side of (6) by b, we have

$$\gamma=\frac{a}{\frac{a}{b}+1+\frac{c}{b}} \quad . \quad . \quad . \quad (7)$$

Now if we divide (5) by (4), we obtain $\frac{a}{b}=\frac{\beta}{\alpha}$; similarly, dividing (5) by (6), we get $\frac{c}{b}=\frac{\beta}{\gamma}$, and on substituting these values in (7), we find—

$$a=\frac{\alpha}{\alpha\beta+\beta\gamma+\gamma\alpha} \quad . \quad . \quad (8)$$

By symmetry,

$$b=\frac{\beta}{\alpha\beta+\beta\gamma+\gamma\alpha} \quad . \quad . \quad (9)$$

$$c=\frac{\gamma}{\alpha\beta+\beta\gamma+\gamma\alpha} \quad . \quad . \quad (10)$$

Application of Δ—Y Transformation.

We shall conclude the present series of articles by applying the Δ—Y transformation to the solution of the network problem of Fig. 23 (p. 532, vol. III.). For the sake of convenience in diagrammatic representation, the network has been re-drawn in Fig. 28 in a somewhat simpler form, the numbers attached to the various members representing their *resistances*. As in the Coltri-Seydel method already explained, we shall take for our unknown quantities the drops v_A, v_B, v_C, v_D, v_E and v_F from either of the two feeding-points F_1 and F_2 to the nodes A, B, C, D, E and F respectively. The method of solution about to be explained consists essentially in a gradual reduction of the number of nodes in the network by repeated applications of the Δ – Y transformation; and this mode of procedure is precisely analogous to the successive elimination of the variables from a system of simultaneous equations when the ordinary method of solution by elimination (as distinguished from Seydel's method, explained in vol. III.) is adopted.

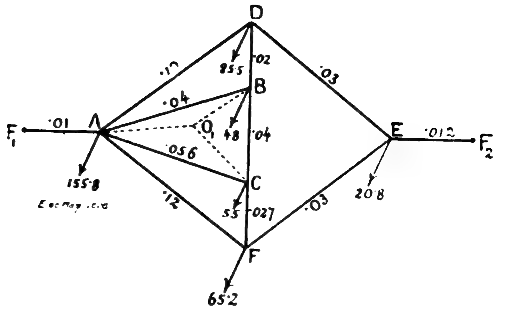


FIG. 28.

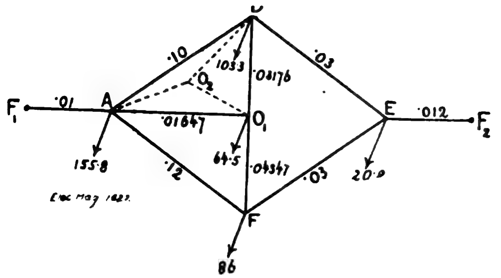


FIG. 29.

We commence by substituting for the $\triangle$ A B C in Fig. 28 the Y indicated by the dotted lines. In determining the resistances of O_1 A, O_1 B, and O_1 C, we make use of the formulæ (4) to (6). We thus find

$$\text{resistance of } O_1 A = \frac{.056 \times .04}{.136} = .01647$$

$$\text{,, ,, } O_1 B = \frac{.04 \times .04}{.136} = .01176$$

$$\text{,, ,, } O_1 C = \frac{.04 \times .056}{.136} = .01647$$

The result of this transformation is the substitution of the single node O_1 for the two nodes B and C.* The resistance of O_1 D $.01176 + .02 = .03176$, and that of O_1 F $= .01647 + .027 = .04347$. We now, however, have a network which is loaded not only at the nodes, but also at the points B and C, which are no longer nodes. In accordance with the method previously employed we have to substitute for the given distribution two others, in one of which all the nodes are feeding-points, while the other is loaded at the nodes only.

Considering the first imaginary distribution we easily find (by considering moments of the component currents about O_1, and D, Fig. 28) that in order to supply a current of 48 amperes at B, a current of 30.23 amperes must be fed into O_1 B at O_1, and a current of 17.77 amperes into D B at D. Similarly, in order to supply a current of 55 amperes at C, a current of 34.15 amperes must be fed into O_1 C at O, and a current of 20.85 amperes into F C at F. Hence in the second imaginary distribution, in which the network is loaded at the nodes only, the total load current at D is $85.5 + 17.8 = 103.3$ amperes; that at O_1 is $30.23 + 34.15 = 64.5$ amperes, say: and that at F is $65.2 + 20.85 = 86$, say (Fig. 29).

Now since the potential drops are determined solely by the second imaginary distribution, the first imaginary distribution need not be further considered. The second imaginary load distribution is shown in Fig. 29. As before, we proceed to reduce the number of nodes by substituting for the $\triangle$ A O_1 D the Y indicated by the dotted lines radiating from O_2. Using the formulæ (4) to (6), above, we find

$$\text{resistance of } O_2 A = \frac{.01647 \times .1}{.1482} = .01111$$

$$\text{,, ,, } O_2 D = \frac{.1 \times .03176}{.1482} = .02143$$

$$\text{,, ,, } O_2 O_1 = \frac{.03176 \times .01647}{.1482} = .00353$$

The resistance of $O_2 E = .02143 + .03 = .05143$, that of $O_2 F = .00353 + .04347 = .047$. Again we have a network in which, besides load currents at the nodes, there are load currents at the points D and O_1, now no longer nodes; and again we "transfer" these load currents to the nearest nodes by making use, as before, of the two imaginary distributions which may be made to replace the real distribution. We thus find for the part of the current of 103.3 amperes at D which is transferred to E the value $\frac{103.3 \times .02143}{.05143} = 43.03$ amperes, and for the part transferred to O_2, 60.27 amperes. Similarly, the part of the current of 64.5 amperes at O_1 transferred to F is 4.84, and that transferred to O_2 is 59.66 amperes. The new load distribution is shown in Fig. 30, the load current at E being $20.8 + 43.03 = 63.8$ amperes, say; that at F is $86 + 4.84 = 90.84$, and that at O_2 $60.27 + 59.66 = 119.9$ amperes.

A further reduction in the number of nodes

* A node being the meeting-point of *at least* three conductors.

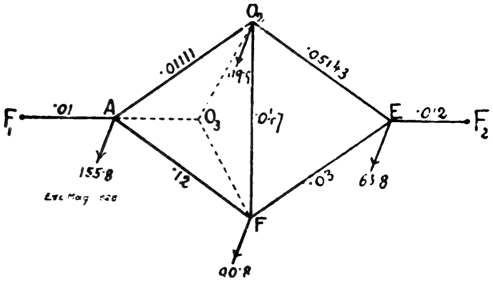


FIG. 30.

is next made by replacing the $\triangle$ A O_2 F in Fig. 30 by a Y, as shown by the dotted lines. Proceeding as before, we find :—

$$\text{resistance of } O_3A = \frac{.12 \times .01111}{.1781} = .007484$$

$$\text{,, \quad ,, } O_3O_2 = \frac{.01111 \times .047}{.1781} = .002932$$

$$\text{,, \quad ,, } O_3F = \frac{.047 \times .12}{.1781} = .03167$$

The resistance of O_3E is thus .002932 + .05143 = .05436, and that of O_3E is .03167 + .03 = .06167 (Fig. 31). Next, "transferring" the current of 119.9 amperes at O_2 to the nodes E and O_3, we find for the part transferred to E, 6.47 ; and for that transferred to O_3, 113.46 amperes. Similarly, considering the current of 90.8 amperes at F, we transfer 46.65 amperes to E and 44.15 amperes to O_3. The total load current at E now becomes 63.8 + 6.47 + 46.65 = 116.9 ; and that at O_3, 113.46 + 44.15 = 157.6 amperes.

We now have the load distribution sketched in Fig. 31, and since there are no currents taken off along either of the two parallel paths between O_3 and E, we may substitute for the two branches a single conductor of equivalent resistance $= \frac{.05436 \times .06167}{.05436 + .06167} = .02891$ ohm, thus arriving at the simple case (shown in Fig. 32) of an unbranched distributor fed from both ends.

Assuming O_3 to be the point of lowest potential, and denoting the currents flowing towards it by x and y, we have, by the principle of moments,

$$1.558 + .01748x = 1.403 + .04091y.$$

But we also have $x + y = 157.6$. Solving these equations, we find $x = 107.6$, $y = 50$. This gives for the current in the section F_1A the value

$$155.8 + 107.6 = 263.4 \text{ amperes,}$$

and for the drop V_A from F_1 to A, 2.634 volts, a result in agreement with that previously obtained by the Coltri-Seydel method (p. 247).

Similarly, we obtain for the current in the section F_2E

$$116.9 + 50 = 166.9 \text{ amperes,}$$

and for the drop V_E, .012 × 166.9 = 2 volts, which also agrees with the result previously obtained.

By working backwards through the chain of transformations, Figs. 28—32, we easily obtain the complete current distribution in the original net-work as follows.

The current in the section E O_3, Fig. 32, is—as we have just found—50 amperes, and flows from E to O_3. This current in Fig. 31 divides between the two parallel paths, the current along the upper branch being 26.6, and that along the lower branch 23.4 amperes. On passing to Fig. 30, we have, in proceeding along E O_2, to add to the current of 26.6 amperes just found the "transferred" current at E corresponding to part of the 119·9 amperes at O_2; on referring back to our calculations, we find that this amounted to 6·47 amperes. Thus the current along E O_2 in Fig. 30 is 26.6 + 6.47 = 33.1 amperes, say. Similarly, the current along E F is 23.4 + 46.65 = 70.1 amperes. The drop along E O_2 is .05143 × 33·1 = 1,702 volts, and that along E F is .03 × 70.1 = 2.1 volts. Hence there will be a current along O_2F (Fig. 30) of amount $\frac{2.1 - 1.702}{.047} = 8.5$ amperes. There must thus be a current along A O_2 amounting to 119.9 + 8.5 − 33·1 = 95.3 amperes, and a current along A F amounting to 90.8 − 70.1 − 8.5 = 12.2 amperes.

Proceeding next to Fig. 29, we obtain the current in E D by adding to the current in E O_2 of Fig. 30 the corresponding transferred current, which amounted to 43 amperes. Thus current in E D, Fig. 29, is 33·1 + 43 =

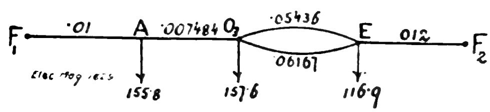


FIG. 31.

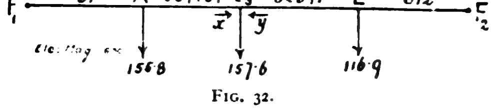


FIG. 32.

76.1 amperes. Similarly, current in $F\ O_1 = -8.5 + 4.84 = -3.66$. Further, drop along $E\ F\ O_1 =$ drop along $E\ F_1 +$ drop along $F\ O_1 = 1.94$ volts, and that along $E\ D = .03 \times 76.1 = 2.283$ volts. Hence there will be a current along $O_1\ D = \dfrac{2.28 - 1.94}{.03176} = 10.8$ amperes. We next find—

Current along $A\ D = 103.3 - 10.8 - 76.1 = 16.4$ amperes.

Current along $AO_1 = 64.5 + 3.66 + 10.8 = 79$ amperes.

This completes the determination of the current distribution in Fig. 29, and we finally have to go back to Fig. 28:—

Current along $D\ B = 16.4 + 76.1 - 85.5 = 7$ amperes;

drop along $D\ B = .02 \times 7 = .14$ volt;

$\therefore$ drop along $A\ B = .1 \times 16.4 + .14 = 1.78$ volt,

and current along $A\ B = \dfrac{1.78}{.04} = 44.5$ amperes.

Current along $B\ C = 44.5 + 7 - 48 = 3.5$ amperes,

and current along $A\ C = 263.4 - 155.8 - 16.4 - 44.5 - 12.2 = 34.5$ amperes,

Hence current along $F\ C = 12.2 + 70.1 - 65.2 = 17.1$ amperes.

The current distribution is thus completely determined. The values obtained, it may be noted, are in practical agreement with those found previously by the Coltri-Seydel method and indicated in Fig. 24.

How to Make an Electric Buckboard.

By J. C. BROCKSMITH.

(Concluded from p. 311.)

The Battery and Controller.

The builder may have his choice of any of several good makes of storage batteries which can be used in this machine. The battery compartment is of suitable size to contain 16 cells E 18 Edison battery; also an Exide battery of 16 P V 5 cells can be accommodated.

In case the Edison battery is used, the motor would have to be wound for 20 volts, and in the case of the Exide battery the winding would be for 32 volts. Just what the winding will be for any voltage can be easily deduced from the figures already given by remembering that a reduction in the voltage of one-half would mean an increase in the cross-section of both field and armature wire to double the previous value, or an increase in the size of three gauge numbers. In this way any winding may be computed by simple proportion.

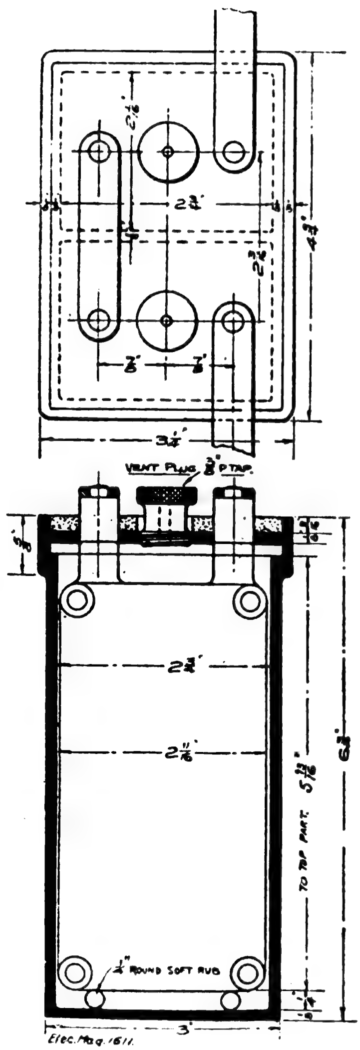


FIG. 20.

For the benefit of those who wish to construct their own battery, one used by the writer with good results will be described. The battery is of the lead type with pasted plates, the paste being applied to grids cast from an alloy of lead and antimony, containing 12 per cent. of the latter metal.

Fig. 20 illustrates the complete double-cell unit. A rubber jar is used which has a partition in the centre; each compartment contains a five plate element consisting of 2

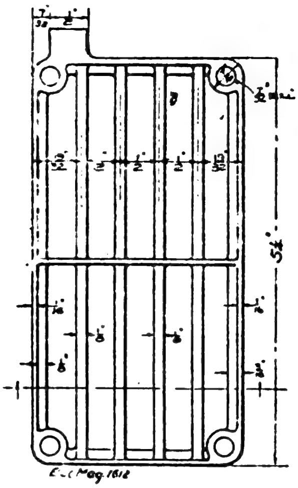


FIG. 21.

positives and 3 negatives, the end negatives being only one-half the thickness of the other plates. The weight of each element alone is $3\frac{1}{4}$ pounds, and the weight of the complete double cell with solution is $8\frac{1}{2}$ pounds.

Fig. 21 is a detail of the grid used for both positives and negatives. It consists of a light rectangular frame having sides of T-shaped section and provided at the corners with bosses for the binding rods to pass through. The frame serves to give a definite form and thickness to the mass of active material, and the current is conducted to and from the mass by means of the vertical rods which are imbedded in the active material.

A lug is provided at the top of the grid for making connections with the finished plate.

The material which is applied to the positives consists of minium or red lead with a slight admixture of litharge. This is moistened with a solution of ammonium sulphate, and while in a plastic condition the grid is filled until the material stands a trifle above the edges of the frame. The grid and contents are then subjected to a strong pressure between some layers of blotting paper in a suitable press, which removes the excess moisture and compacts the material so that it now is flush with the edges of the frame.

The negative grids are treated much the same as the positive, except that in this case the material consists of litharge with a slight addition of red lead, and the whole is moistened with dilute sulphuric acid.

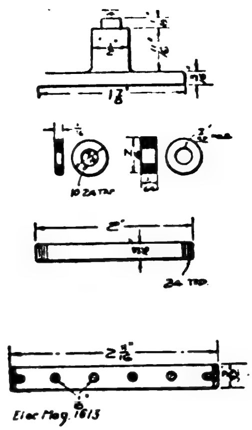


FIG 22

After the plates have been prepared in this manner and have been allowed to become dry and hard, they are assembled in the form of elements by means of the hard rubber rods and washers shown in detail in Fig. 22. It is not necessary to use pure hard rubber for this purpose; some of the cheaper compositions will answer just as well.

The washers can be most conveniently cut from a tube of suitable diameter. In addition to the rods and washers some perforated and corrugated separators are slipped between the plates as additional precaution against short-circuits.

When the plates are properly assembled the plates of the same polarity are connected together by soldering on the pillar connecting pieces shown in detail in Fig. 22. These are cast of lead-antimony the same as the grids; in order to protect the terminals from being acted on by the electrolyte, they should be dipped in acid-proof paint after being soldered on.

The elements are now placed in their jars and connected in series and formed by passing a current in one direction through them, preferably continuously, until all the

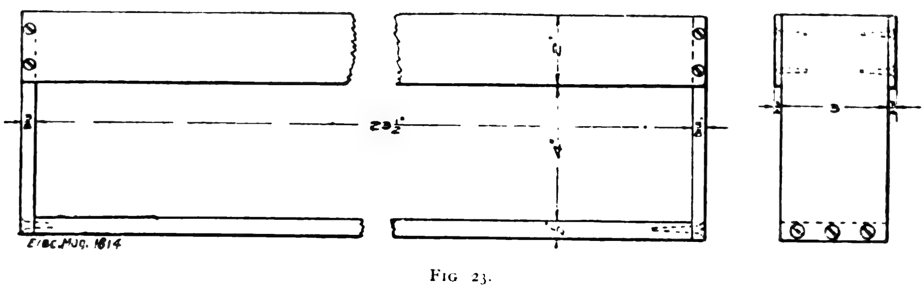


FIG 23.

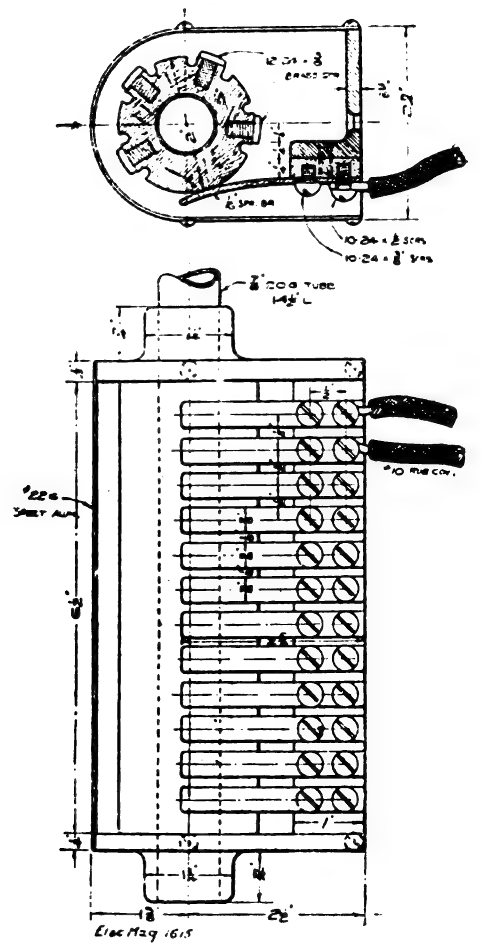


Fig. 24

material on the positives has been converted into peroxide, by which time the negatives will also have been reduced to spongy lead. The state of formation is best determined by the appearance and colour of the plates, which should be a deep brown, almost black, when wet, for the positives, and a dark slate colour for the negatives; the colour, of course, should be uniform all over the plate.

During the process of forming, the electrolyte used should be of much lower strength (about 1100 sp. gr.) than the regular used during working the cell, in order to avoid as far as possible sulphating the material, which would delay the formation. When fully formed the forming solution may be turned out, the plates washed, and replaced in the regular electrolyte of 1250 sp. gr., which must be mixed and allowed to cool before being placed in the jars.

Each cell may now be sealed by pouring in on top of the cover a layer of sealing compound which is heated until quite fluid and will then adhere firmly to the sides of the jar, rendering it acid tight.

In order to combine the cells in convenient units for handling and connecting to the controller some wooden trays are necessary, which are shown in Fig. 23. Four such trays are used, each containing five double cells. The trays are best made of cherry, and should be well painted with P. & B. or acid-proof paint.

In the operation of the vehicle the cells should not be discharged below 1.75 volts per cell or 70 volts for the entire battery in series. In charging a high rate can be used at first, if the cells were completely discharged; this should be gradually reduced, as the charge comes up, until the battery shows about 102 or 103 volts, with a current of 3 amperes flowing, when they may be considered fully charged.

The battery should be gone over occasionally and the condition of each individual cell determined to see that the electrolyte is of the proper strength and completely covers the plates, and that the voltage is

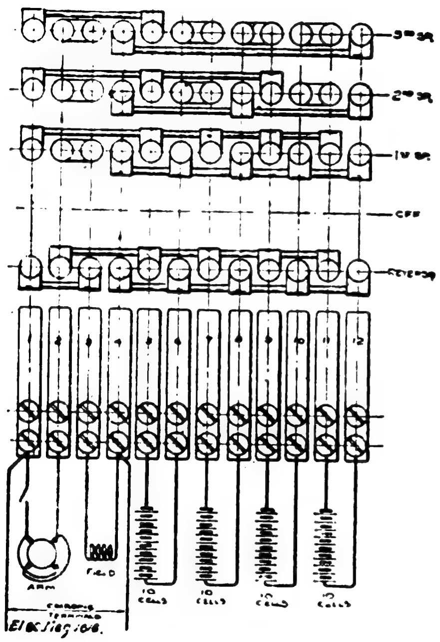


Fig. 25.

right and there are no weak cells. About once in six weeks is often enough for this inspection if the vehicle is used moderately often.

Fig. 24 shows a sectional plan and elevation of the controller. It is of very simple construction, consisting of a hard wood cylinder 2in. in diameter, which has four rows of brass screws, each row containing 12 screws. Upon this cylinder 12 flat springs of hard brass or bronze press and make contact with the successive rows of screws as the controller cylinder is moved from one position to another. There are five positions of the cylinder, one of which, however, has no contacts engaged, this being the "off" position.

The frame of the controller is a casting, preferably of alzinc, consisting of a semicircular top and bottom connected by a ribbed back piece all cast in one. Against the rib at the back of the frame is mounted a strip of fibre $\frac{1}{4}$in. thick and 1in. wide, which is tapped for screws that fasten the brass contact springs in position. Connections are also made to these same screws.

For convenience in making connections between the screw heads on the cylinder it has longitudinal grooves cut at each side of every row of buttons. Small clips of thin sheet copper are fastened under each screw head and soldered to bare copper wires laid in the grooves. The grooves are then filled in with plaster of Paris so that the cylinder presents a smooth surface. Ordinary round head brass machine screws are used for this purpose, and after all connections have been made the cylinder is mounted on its sleeve of steel tubing and placed in the lathe, and all the screw heads turned down to a uniform diameter, projecting about $\frac{1}{16}$in. above the surface of the cylinder.

Fig. 25 is a diagram of connections which is intended to serve as a guide in making the taps on the controller cylinder, and also in connecting the motor and battery leads to the contact springs.

On the first speed all the four battery sections are in multiple, giving 20 volts at the motor. On the second speed the battery is half in series and half in multiple, giving 40 volts at the motor, while on the last notch the cells are all in series, giving 80 volts on the motor and the highest speed. The reverse is just the same as the first forward speed, except that the armature leads are interchanged, thus reversing the direction of rotation.

The Woodwork.

This is of the simplest description; only straight boards are used. The curved surfaces usually seen on automobile bodies would probably be out of question for anyone wishing to construct the woodwork himself. On the other hand, the boards can be shaped on the edges with comparatively little extra labour, so as to make quite an attractive appearance. The shape of the seat panels and the dimensions for them are shown in Figs. 1 and 3 All of the woodwork is intended to be made of ash and looks very well when finished in the natural wood colour by putting on two or three coats of orange shellac rubbed down with fine sand paper between each coat. This treatment brings out the natural grain of the wood, and while it is simple and inexpensive still gives very good results.

The flooring also is composed of ash boards 6in. wide and $24\frac{3}{4}$in. long and $\frac{3}{8}$in. thick, laid on the lower flange of the angle frame, and fastened thereto by means of $10\text{-}24 \times \frac{1}{2}$in. flat head machine screws, 4 to each board. The flooring is shellaced the same as the other woodwork.

The tool compartment under the seat is provided with a hinged door, which opens from the back and closes with a small drawer lock. In this compartment should also be installed a single-pole, single-throw knife switch, placed in one of the motor armature leads. This is to be open while charging, and also when leaving the machine unattended it can be opened and the door of the compartment locked, when it will be impossible to run the machine without first unlocking the door.

The following is a list of stock required for the woodwork:

Wanted for.	Pieces.	Size.
Seat sides	2	$19 \times 8 \times \frac{3}{8}$
Seat back	1	$32 \times 8 \times \frac{3}{8}$
Seat panels	2	$16\frac{1}{2} \times 17\frac{1}{2} \times \frac{1}{2}$
Seat bottom	1	$32 \times 18\frac{1}{2} \times \frac{3}{8}$
Front and back tool compartment	2	$32 \times 7 \times \frac{3}{8}$
Seat fillets	2	$8 \times 1\frac{1}{4} \times 1\frac{1}{4}$
Front crosspiece	1	$24\frac{3}{4} \times 2 \times 1\frac{1}{4}$
Middle crosspiece	1	$24\frac{3}{4} \times 2\frac{1}{2} \times 1\frac{3}{4}$
Flooring	12	$24\frac{3}{4} \times 6 \times \frac{3}{8}$
Battery trays	4	$23\frac{1}{2} \times 3 \times \frac{1}{2}$
Battery trays	8	$6\frac{1}{2} \times 3 \times \frac{3}{8}$

Dressed all over, grain to run in direction of dimension appearing first in above list. Where boards are too wide to be made in one piece they may be "edged up" in two widths.

WIREMEN'S Section

Electric Light & Power Wiring

Artisans

Wiremen and Artisans should refer to the World's Electrical Literature Section for classified list of articles on subjects of importance to themselves.

Lead-Covered Wiring.

By JOHN D. MACKENZIE.

In the following remarks I shall endeavour to place the advantages and disadvantages of lead covered wiring side by side, and show how some of the disadvantages may be minimised :—

Advantages.—1. The wire comes to the contractor, already provided with its own continuous metallic sheathing, and generally requires no further protection.

2. The sheathing is watertight, and the whole installation can quite readily be made so too.

3. The great flexibility of the wire enables it to be installed with much less damage to buildings.

4. The small diameter of the wire enables it to be used in surface work, where any other system would be an eye-sore.

5. The difficulty of making joints practically compels the adoption of a loop-in system.

The disadvantages urged against the system are many and various, but fall under two general heads, viz. :—

1. Risk of injury during erection.
2. Risk of injury after erection.

To that, some add the risk of injury during manufacture. This, however, with the exception of one point, is no greater in lead-covering than in the ordinary taped and braided wiring. The one point of difference is in the heating to which the wires are subjected during the process of sheathing. Considering, however, the rapidity with which the wires are run through the lead press, and the tests which are afterwards applied to these cables, and which they successfully stand, the risk of damage seems very slight.

It is far preferable to use single lead-covered wires, with the lead sheathing properly bonded and earthed, because it then requires two "earths"—one on each wire before one obtains a short-circuit, and on public supply systems an "earth" on the live wire means the blowing of a fuse.

The risks of injury during erection arise from (*a*) the carelessness of the wireman, and (*b*) from the carelessness of other workmen.

(*a*) The careless wireman cuts into the insulation when stripping off the lead sheathing: overheats and softens the insulation when sweating the sheathing into boxes for a watertight system; overlooks the pin-holes caused by heated air bursting through the melted solder at such boxes; pulls the lead sheathing too hard, so making it brittle, and then it cracks when bent; hammers on his saddles too tight, and perhaps puts them on twisted, so cutting the lead by the edge of the saddle.

(*b*) The carelessness of other workmen is shown:—By the plasterer who cuts the lead with his trowel; the labourer who drops a shovel on it; the joiner who nails the flooring board to it; and by any man who walks with hobnailed boots over the top of it.

The risks after erection are :—

(*a*) The lead gives very little mechanical protection, from nails, for example.

(*b*) It may be successfully attacked by rats and mice.

(*c*) If a failure of insulation takes place,

a wire cannot readily be withdrawn and replaced.

(*d*) Lead expands with increase of temperature, and may not go back to its original length when cold, and hence it may come in contact with other meta's, or may even get cracked and broken.

(*e*) The electrical resistance of lead being high, contact with other metals may form a better "earth" than the proper earth connection.

(*f*) When an "earth" comes on, the lead may fuse at the point of contact as quickly as the fuse wire does.

(*g*) Pure water in the presence of air, and water containing salts in solution, such as ammonia, have a solvent action on lead.

(*h*) Decaying animal or vegetable matter under floors, &c., produce acetic acid, which acting on the lead sheathing, has also a deleterious effect by forming "white lead."

(*i*) The presence of other metals, such as brass saddles in damp situations, causes electrolytic action.

(*j*) Where the lead sheathing is bared back to allow the wire to enter a switch or other fixture, there is a tendency for the current to creep on to the lead and escape at some other point, causing electrolytic corrosion.

The next point which arises is the question—"Is it possible to overcome or minimise the risks?"

Taking (*a*), viz., the careless wireman, it is quite possible to get *careful* workmen who will do *none* of these things; and, in any case, will a careless workman not cut into the insulation when removing the braiding from ordinary wire—will he not twist and kink the wire when drawing it into conduit, will he not leave ragged edges on his conduit so as to tear the insulation, will he not attempt to draw too many wires into a conduit, so straining the insulation and breaking the strands of wires; in short, what will the careless wireman *not* do? *Ergo*, get rid of him as quickly as you can.

(*b*) The risk of injury from other tradesmen is always present, and where lead-covered wiring has to be carried out while a building is in course of erection, special precautions must be taken to avoid injury—*e.g.*, laying temporary boarding over the runs of wire on the floors, lapping up with tape where coming out through plaster work, &c.

The faults after erection make the most formidable list, but it is quite possible to minimise these considerably.

(*a*) This point is made a good deal of by the opponents of lead-covered wiring, but seems to me to be grossly exaggerated. During the last seven years I have only had three instances in which lead wiring was damaged through nails or similar articles having been driven through the plaster work.

(*b*) This again is much exaggerated. Rats and mice have teeth which can easily work havoc on lead wire, but they seldom do so, and my own personal experience supplies no instance. These rodents will only attack lead wiring or lead water-pipes when in the direst straits for food or drink.

(*c*) This is the only point where conduit systems can show any real superiority over the lead-covered. The usual method with lead-covered wiring is to plaster it right in, and consequently it is impossible to withdraw it without damage to the plaster work. Several years ago the writer adopted the system of putting thin close-joint tubing in such walls as would be plastered up solid, dropping the lead-covered wires down this tube and drawing them taut, then placing an insulating bush top and bottom of tube, thus giving the advantage of a conduit system and also some more protection against an exploring nail.

(*d*) Here we have a fault not so much due to the lead-covered wire itself as to its indiscriminate use. Where wiring is to be subjected to *very* great variations in temperature, lead should not be used, but the writer has never found the ordinary temperature changes in house or shop to have any appreciable effect on the lead sheathing.

(*e*) In order to overcome this, all that is necessary is to bond all the lead wires together at frequent intervals, and so get the advantage of all the sheathing. For this purpose the writer uses a solder containing a large proportion of lead, and has found no trace of electrolytic action even in damp situations after years of use.

(*f*) The foregoing method of bonding the wires together tends to prevent the lead sheathing melting before the fuse does.

(*g* and *h*) The solvent effects of water with either air or salts in solution are certainly a possible disadvantage, but no more so than with thin enamelled conduits, which rust through in a very short time. Except under very exceptional circumstances, the amount of acetic acid which can be formed by decay-

ing matter will not seriously harm the average lead-covered wire.

(*i*) Electrolytic action between brass saddles and the lead sheathing may quite easily be overcome by the use of lead saddles, which are quite as efficient.

(*j*) The current creeping along the insulation and on to the sheathing and causing electrolytic corrosion is also easily overcome by dipping the ends of the wires up to the sheathing in melted joint-box compound. This also helps to increase the insulation resistance of the whole job.

The faults which so often occur on lead-covered wiring are all due to carelessness in the workmen, or because the conditions under which the wire is to work have not been properly appreciated. And the advantages to be obtained by the use of lead-covered wire make it easily worth the time spent in considering all the necessary circumstances. An example of what *not* to do was given a good many months ago in a letter published in these columns, where lead-covered wires had been drawn into iron gas pipes laid in the ground, with the inevitable result, viz., breakdown. Here the lead covering was no doubt scratched, and perhaps cut while being drawn in by the roughnesses inside the tube, and then it lay touching the iron and perhaps surrounded by moisture, either leaking in through pipe joints or due to condensation inside the tube, thus giving the very best chance for electrolytic action. No one knowing the limitations of lead-covered wire would suggest or carry out such an arrangement, instead of which the wire ought to have been laid either in wood troughing and pitched in solid, or drawn into smooth earthenware or concrete conduits. It is the adoption of such obviously foolish arrangements as indicated which has given lead-covered wiring a name for want of reliability, and I trust the foregoing remarks may indicate, in some small measure, how to overcome some of the difficulties.—Abstracted from the *Electrical Review.*

"Die Elektrolyse Geschmolzener Salze." Zweiter Teil.

("The Electrolysis of Fused Salts" Part II.) By R. LORENZ, Halle a S: W. Knapp. 1905. Price M. 8.

The present volume, which forms Part II. of the exhaustive treatise on the electrolysis of fused salts now in course of publication by Messrs. W. Knapp as one of the well-known series of "Monographs on Applied Electrochemistry," is replete with interest. The subjects dealt with are Faraday's Law, the Migration of the Ions and Conductivity. Never before have these difficult subjects (considered with reference to *fused salts* as distinguished from *aqueous solutions*) been handled in so masterly a fashion, nor has the information available on the subject been ever before presented in so lucid and interesting a form. The section dealing with Faraday's Law and the conditions which determine the electrolytic efficiency of a cell are worthy of the closest study by all interested in the industrial applications of electro-chemistry. Of very special interest are also the chapters in which the so-called "metallic fogs" are considered—a subject to which the author has personally contributed in no mean degree. The volume is one deserving of the warmest commendation, and will be found most stimulating and suggestive by all workers in the field of research with which it deals.

"Synchronmaschinen für Wechsel- und Drehstrom."

("Synchronous Machines for Single-phase and Polyphase Currents.") By W. WINKELMANN, Hannover: M. Jänecke. 1905. Price M. 4.

This little book of 148 pages forms Vol. IV. of "Repetitorien der Elektrotechnik," and within this extremely moderate compass the author succeeds in imparting to his reader an amount of information which is truly wonderful. After a general introduction dealing with the generation of E.M.F. and the fundamental principles of alternating currents, the author considers the various factors which affect the magnitude of the E.M.F. Then follow chapters on the losses in synchronous machine, on heating, and on the calculation of the field winding. The important subject of armature reaction receives adequate treatment in a special chapter. Synchronous motors, parallel running, self-excitation, and compounding are dealt with in the next three chapters, and the remainder of the volume is devoted to the shape of the current wave in inductive circuits containing iron cores, the dimensions of synchronous machines, and alternator design.

Power.

Articles.

Niagara Power in the Gorge.	*Elec. Wld. & Engr.* 18/11/05.
Tar Burning in Gas and Electric Plants.	*Progress. Age.* 1/11/05.
Water Turbine Plants.	*Elek. Zeit.* 19/10/05.
*Efficiency of Electrical Power Generating Stations. H. M. Hobart.	*Elec. Wld. & Engr.* 25/11/05.
Three-Phase Motors Operated from One-Phase Mains. Dalemont.	*Elek. Zeit.* 2/11/05.
The American and Canadian Channels of Niagara Falls. A. D. Adams.	*Elec. Rev.*, N.Y. 11/11/05.
A Converted Gas-Electric Lighting Plant.	*Elec. Rev.*, N.Y. 11/11/05.
Hydro-Electric Plant on Spring River, Kansas.	*Elec. Rev.*, N.Y. 18/11/05.
Les Clées-Yverdon Hydraulic Plant. C. L. Devrand.	*Elec. Rev.* 18/11/05.
Converter Station for Vevey Railway, Switzerland. A. de Courcey.	*Western Electn.* 25/11/05.
Colliery and Mining Switchgear for H. and L. T. A. C. Service. A. M. Randolph.	*Elec. Rev.* 10/11/05.
Transmission Plant of the Mexican Light and Power Co. F. O. Blackwell.	*Canad. Elec. News* Oct./05.
Reinforced Concrete Poles.	*Canad. Elec. News* Oct./05.

Papers.

Electric Mains for Power Transmission. J. T. Morris.	*Junr. Inst. Eng.* 15/12/05.

Traction.

Articles.

*Heavy Electric Railroading. B. Valatin.	*Elec. Wld. & Engr.* 18/11/05.
Electric Towing.	*Elec. Wld. & Engr.* 18/11/05.
Three-Wire Systems of Traction.	*Elek. Bahnen.* 24/10/05.
Electric Traction in Berlin.	*Elek. Zeit.* 26/10/05
Electrification of the New York Central Suburban Lines. (*See* "Traction" this month.)	*Elec. Rev.*, N.Y. 11/11/05.
Improvements in the Grand Central Station of the New York Central. (*See* "Traction" this month)	*Elec. Rev.*, N.Y. 18/11/05.
New York Central Electrification.	*Strt. Rly. Jour.* 18/11/05.
Rapid Track Laying on the Fort Wayne and Wabash Valley Road.	*Strt. Rly. Jour.* 25/11/05.
*Surface Contact Systems.	*Elec. Rev.* 10/11/05.
Present Status of Chicago Freight Tunnels.	*Westn. Elect.* 18/11/05.

Papers.

Influence of Traffic Conditions on Motor Specifications. A. H. Armstrong.	*Brooklyn Polytech.* 8/11/05.
Interurban Express and Freight Traffic. N. E. Graston.	*Indiana Elec. Rly. Assn.* 9/11/05.
Some Aspects of Electric Traction. W. M. Mordey.	*Inst. E.E. Stdnts.* 15/11/05.
Electrification of Existing Steam Railways. W. H. M. Parr.	*Manch. I. E.E.* 8/12/05.

Lighting and Heating.

Articles.

Graphitising Filaments Expired. E. P. Thompson.	*Elec. Wld. & Engr.* 25/11/05.
*Reflectors, Shades, and Globes. J. R. Cravath and V. R. Lansingh.	*Elec. Wld. & Engr.* 25/11/05.
Efficiency of Illuminants. F. B. Badt.	*Western Electn.* 18/11/05.

Papers.

*Street Lighting. H. T. Harrison.	*Manchester I.E.E.* 12/12/05.
Flame Arc Lamps. L. J. Pumphrey.	*I. E. E. Students* 13/12/05.

Telegraphy and Telephony.

Articles.

A Method of Testing Wireless Telegraph Receivers. G. W. Pickard.	*Elec. Wld. & Engr.* 25/11/05.
Long Distance Telegraphy in Australia. T. Howard.	*Elec. Rev.*, N.Y. 25/11/05.
German Fire-Alarm Systems. A. Gradenwitz.	*Western Electn.* 11/11/05.

Paper.

Measurement of High-Frequency Currents and Electric Waves. J. A. Fleming.	*Soc. Arts* 4/12/05.
Recent Advances in Wireless Telegraphy. J. Erskine-Murray.	*Glas. I E.E.* 12/12/05.

Electro-Chemistry.

Articles.

Guarding Against Electrolysis of Underground Pipes. P. A. Bates.	*Elec. Rev.*, 11/11/05.

Electric-Physics.

Articles.

Linear and Rotating Hysteresis. Weeken	*Zeit. f. Elek.* 2/11/05.
The Electrical Nature of Matter and Radio Activity. H. C. Jones.	*Elec. Rev.*, N.Y. 25/11/05.

Electro-Metallurgy.

Articles.

Magnetic Alloys from Non-Magnetic Metals. Hill.	*Phy. Rev.* Nov./05.

Design and Manufacture.

Articles.

A Small Motor Testing Equipment. R. T. Wells.	*Elec. Wld. & Eng.* 25/11/05.
Some Recent Developments in Gas Engines.	*Elec. Rev.*, N.Y. 11/11/05.
A New Process of Wire-covering.	*Elec. Rev.*, 1/12/05.
Separation of Iron and Friction Losses in D.C. Machinery. F. H. Page.	*Elec. Rev.*, 1/12/05.
Parker Dynamos With Auxiliary Poles.	*Electrn.*, 28/11/05.
Permutators. C. V. Drysdale.	*Electrn.*, 8/12/05.
Standards of Mutual Induction. By F. C. Searle and J. R. Airey.	*Electrn.*, 8/12/05.

Papers.

Testing of Motors. T. Carter.	*Newcastle I.E.E.* 12/12/05.

Central Station Practice.

Articles.

Testing Earth Connections. Corsepius.	*Elek. Zeit.* 20/10/05.
Electricity Meters. C. H. W. Gerhardi. (Serial)	*Electrician*, 28/11/05.
The Multiple Operation of Transformers. R. T. McKeen.	*Can. Elec. News.* Nov./05.
Accidents Due to Faulty Piping and Incorrect Methods of Starting and Stopping Engines. T. Hall.	*Power*, Nov./05.
Conversion of Heat into Work by Adiabatic Expansion. A. M. Levin.	*Power*, Nov./05.
Increasing Profits of a Central Station. G. E. Walsh.	*Amer. Elec.* Nov./05.
Meter Testing Equipment. R. L. Ellis.	*Amer. Elec* Nov./05.

Papers.

Boiler House Practice and Design. E. Barrs.	*Inst. Mech. Engrs.* 18/11/05.
Two New Electricity Meters. S. H. Holden.	*Brhm. I.E.E.* 13/12/05.

Wiremen.

Articles.

Lead-Covered Wiring. J. D. Mackenzie	*Elec. Rev.* 10/11/05.
Notes on the Standardisation of Fuses. A Schwartz.	*Elec. Rev.* 1/12/05.

A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section.

How to Prevent Heated Bearings.

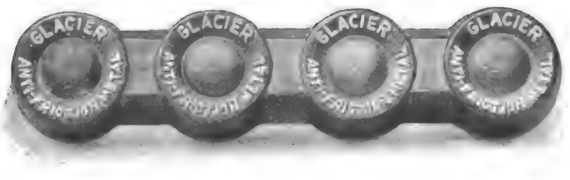
THE question of how to overcome and prevent heated bearings has occupied the attention of engineers for many years, but this attention has in the past been directed more carefully to lubrication, without sufficient attention being given to the bearing itself or the character of the metal of which it is made. There are certain alloys that heat under high speeds and heavy pressures, no matter how carefully lubricated, and usually this heating can be traced to one of the three following causes, viz.:

The use of dross, or oxidation products, in the manufacture of alloys, which result in particles of the dross or oxidised metals being mechanically enclosed in the mixture, causing a hard cutting surface to be presented to the journal, which in time causes increased friction and heating.

Segregation.—This is caused by inexperienced persons attempting to alloy metals, with the result that instead of a metal of uniform hardness and heating capacity, there is a mixture, some portions of which are relatively hard and others soft, and this difference, combined with that occasioned by the varying heating capacity of the different portions, naturally localises friction, and results in excessive heating.

Coarse Crystalline Structure.—A metal of this type not only shows serious weakness, but also such an increase of frictional qualities that it wears away rapidly, and cool running under even ordinary conditions becomes very difficult. The improvements in machinery during late years have made it necessary to change and improve the old formulas of bearing metals. While the old formulas of a quarter of a century ago answered the requirements at that time, the increased weight and speed of machinery of the present day demand a metal of very different characteristics. While formerly great stress was laid upon the chemical composition of the alloy, comparatively little attention was paid to the relation existing between structure and efficiency, with the natural result that heated bearings became prevalent when the weight and speed of the machinery materially increased. Attention was thus directed to the production of a bearing metal that would meet the requirements of this increased weight and speed; and about six years ago the Glacier Anti-Friction Metal Co., Ltd., 91, Queen Victoria Street, London, E.C., placed on the market their Glacier Anti-Friction Metal, as possessing all the qualities so necessary to a bearing alloy.

This metal is a fine, close-grained mixture, homogeneously alloyed, and containing the necessary ingredients to produce an alloy of uniform strength and toughness, capable of working satisfactorily under the heaviest pressures or highest speeds. Only virgin materials are used in its manufacture, and no scrap, dross, or oxidation products are employed; the result is that by a special process of manufacture, by careful treatment of the virgin materials, and by the introduction of one special ingredient, the makers claim in Glacier metal an alloy that can be absolutely relied upon as being perfectly uniform at all times, and possessing the necessary characteristics that go to make up a perfect bearing



metal. The use of this metal in both high speed and heavy pressure machinery will not only prevent heated bearings, but will keep the bearings in a bright and polished condition, and greatly reduce the friction.

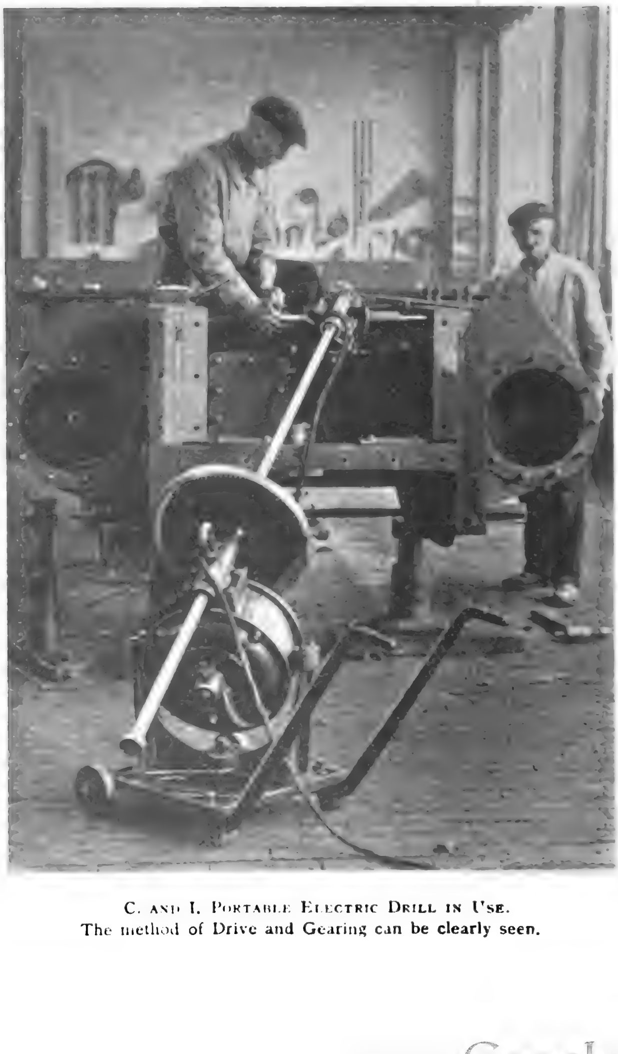
We have seen some very interesting reports from different Governments, railway companies, and engineering firms, as to the excellent behaviour of Glacier metal under the severest conditions.

The illustration shows the form of ingot in which this metal is supplied by the manufacturers.

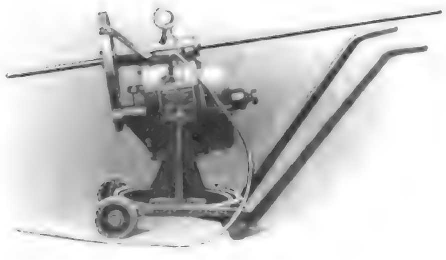
Portable Electric Drills.

THE use of portable electric tools is constantly on the increase, and the perfection of the small electric motor has very largely contributed towards this desirable result. It would be difficult at the present time to enumerate the many processes and operations which can be performed by the aid of portable electro-motors. It is, however, an excellent sign that so much attention is being paid to the subject, and that no opportunity is being lost of applying the electro-motor wherever possible in new fields. An interesting form of portable electric drill is that known as the C. and I. exploited by the United States Metallic Packing Co, Ltd., of Bradford. This machine has been very largely adopted by the foremost engineering firms in the United Kingdom and abroad. It can be used for a variety of purposes, embracing bridge building and general construction work, ship repair work, locomotive and stationary engine building, tram-way track work and colliery work. The drill, as will be seen from the illustration, is direct driven, flexible shafts, knuckle joints, and similar contrivances being entirely dispensed with. At the outset this very greatly simplifies the operation of the tool, while it reduces enormously the loss of power in transmission. We are informed that one man can easily handle the machine, that it is under instantaneous control, and that it can be worked in practically any position.

The drill outfit comprises a motor, carriage, sliding shaft and universal movement drill head. The motor is series wound, this being found preferable to the shunt wound type, the power absorbed being in proportion to the work done. The motor is carried on two horizontal centres by a frame which may be



C. AND I. PORTABLE ELECTRIC DRILL IN USE.
The method of Drive and Gearing can be clearly seen.



C. AND I. PORTABLE ELECTRIC DRILL ON CARRIAGE.

moved in a complete circle, and the whole is mounted on a carriage furnished with handles and wheels to permit of easy movement from place to place (see illustration). If necessary the motor can readily be removed from the carriage and suspended from a stirrup or bow.

On top of the motor is a bracket carrying a hollow shaft fitted at one end with a spur wheel, which is driven from pinion on armature shaft. Through the hollow shaft slides a long shaft, one end of which is connected to the drill head. The long sliding shaft is slotted for nearly its whole length, and this slot fits a key on the inside of the hollow shaft. Thus the motor drives the hollow shaft, and by means of the key and slot the motion is transmitted to the drill head. The gearing on the motor and drill head is entirely covered, thus protecting the workman against accident, and all terminals are protected. The machine can be made reversible for tapping, and arrangements are in progress for fitting the drills with a variable speed attachment where required.

The same company also markets a useful hand electric drill for breast and ratchet feed.

The C. and I. hand electric drill is one of the lightest, most simple, and useful machines of its class on the market. It can be coupled up to an existing lamp holder or wall plug and controlled by a small switch attached to the body of the drill Its applications are numerous, principally for direct drilling as a breast drill, or for working in a drilling pillar with ratchet feed. The motor is capable of drilling holes up to $\frac{3}{4}$in. diameter in metal, but under favourable conditions holes up to $\frac{7}{8}$in. diameter can be drilled. The speed is 1300 revolutions per minute on the motor, and 150 revolutions per minute on the drill spindle. Holes $\frac{1}{2}$in. diameter can be drilled through $\frac{1}{2}$in. plate in 50 seconds, or $\frac{7}{8}$in. diameter in 80 seconds.

New Catalogues.

Angold Arc Lamps.—GENERAL ELECTRIC CO., LTD. Pamphlet number E 1097 gives details and prices of the now famous Angold arc lamp. These are made in ordinary and midget sizes for continuous and alternating currents, and have been specially developed for shop window lighting.

Magneto Ignition Apparatus.— THE GENERAL ELECTIC CO., LTD., sends us a booklet giving particulars of the Coates Patent Magneto Ignition Apparatus for motor cars. The system comprises a magneto generator condenser and coil, and is made for one, two, three and four cylinder engines.

Coal Conveying Plant.—E. BENNIS AND CO., LTD., Little Hulton, Bolton, Lancs. Two booklets have just been issued by this company describing their coal conveying plant at the Metropolitan Electric Supply Company's works and the Grimethorpe, Frickley and Carlton Main Collieries.

A Handsome Calendar.—THE UNITED STATES METALLIC PACKING CO., LTD., Soho Works, Bradford, have just favoured us with an exceedingly striking production in the shape of a calendar for 1906. It is a bas-relief photo production of an allegorical figure representing Progress, and is well worthy a place in every engineer's office.

Boiler Feed Pumps.—FRANK PEARN AND CO., LTD., West Gorton, Manchester. An elaborate publication dealing with this company's boiler feed steam pumps has just been issued. It contains complete descriptions and illustrations of steam pumps of various types, there being single and double-acting donkey-pumps, single and double ram-pumps, and the Pearn Patent Double-acting Pump with one ram. This latter was described and illustrated in our Olympia Souvenir Number, page 74. Engineers interested in modern efficient boiler feed pumps should certainly obtain a copy of this handsome and instructive catalogue.

Electric Lifts.—WILLIAM SPROWSON AND CO., Ascendent Works, Newton Heath, Manchester. A very artistic piece of trade literature is just to hand from Messrs. William Sprowson and Co. dealing very fully with their various types of electric lifts. We have already had occasion to allude to the design and construction of these, so that in again referring to the subject our best plan will be to recommend architects, builders, wholesale proprietors, and parties interested in modern elevating apparatus to apply for a copy of the booklet. The pamphlet comprises a series of loose leaflets printed on one side only and tied by the top corner with silk cord to a handsome yet stout cover.

Nernst Electric Lamps.—THE ELECTRICAL CO., LTD., 121-125, Charing Cross Road, W.C. If central station engineers want an idea for an effective lighting pamphlet they can obtain same from the cover of the latest bulletin describing the Nernst lamp. If a cover of that description does not compel some gas incorrigible to enquire within he isn't worth putting on the mains. We cannot attempt to describe the effect produced by the cover, so we content ourselves with recommending interested parties to obtain a copy both of it and the excellent matter which it surrounds.

Electric Heating.—THE BRITISH PROMETHEUS CO., LTD., Kingston-on-Thames. The cover of the latest pamphlet issued by this company is a very strong appeal to its recipient to examine what lies between its four pages. A bright green background is relieved by strong embossed white letters and the outline of one of the company's radiators. The booklet contains fully descriptive particulars and prices of radiators and convectors, of which many very handsome types are manufactured. The most artistic craze, not to say the most crankish ideas, can be satisfied within the range of the types described.

Electrical Plant.—THE GENERAL ELECTRIC CO., LTD., 71, Queen Victoria Street, E.C. Catalogue Section P dealing with electrical plant well maintains the reputation of this company for being general, for it covers the entire range of direct-coupled, steam, gas and oil engine generator sets, steam turbo-generators, electric lifts and cranes, water turbines, boilers, steam, gas, and oil engines. A truly ambitious group of articles to crowd into the 32 pages of the catalogue. The various pieces of apparatus are briefly described and priced. Printing and illustrations are the best that could be desired.

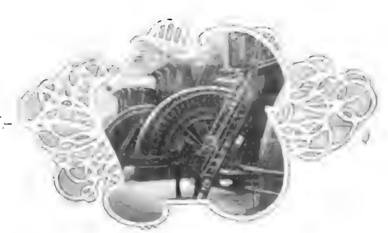
General Electricity.—THE GENERAL ELECTRIC CO., LTD., 71, Queen Victoria Street, E.C. The bound-up copies of the General Electric Company's publications always make an extremely handsome volume. The issue for 1906 is no exception to the rule, and during that period the vast number distributed throughout this country and abroad will doubtless be well-thumbed before the arrival of the next issue. It is quite impossible to review a work of this kind, and in referring to it we can, while complimenting the company on so handsome and useful a compendium of electrical information, recommend all those interested in "general electricity" to present their trade cards for a copy.

B.T.H. Pamphlets.—The pamphlets issued by the BRITISH THOMSON-HOUSTON CO., LTD., of Rugby, are always welcome on account of their delightfully uniform size. The advantage of being able to file pamphlets of standard dimensions must be apparent to methodical engineers. We have just received pamphlets 185 to 188 inclusive, these dealing with a flexible ear for grooved trolley wire, portable electrical measuring instruments, ammeters, wattmeters, and voltmeters for switchboards and miscellaneous switchboard instruments. Among the portable instruments we may specially note a lamp inspector's indicating wattmeter and a series of small pocket ammeters and voltmeters. Frequency indicators and an electrostatic ground detector are important features of the miscellaneous instruments.

Electric Pendants — PLAYER AND MITCHELL, Birmingham. The draughtsman, the clerk, and the mechanic have suffered great inconvenience for many years through the so-called adaptability of electric lighting. Such adjustments of the incandescent lamp lighting their labours as have been vouchsafed to them were only made possible by clumsy temporary expedients which gave no satisfaction and were frequently dangerous. The new electric pendant of Messrs. Player and Mitchell dispenses with boot laces, wire, and temporary props of metal or wood for adjusting the position of a glow lamp. A fitting has been designed and is now marketed in which a light tube is hung from a ball, resting on a cradle at three points. Above the ball is a suitable weight which balances the tube, lamp-holder, shade, and lamp. The friction of the lower ball on the cradle balances the lengthening tube, and compensates with the varying leverage of the latter when pushed in or drawn out. The device is adaptable for the lighting of drawing boards, desks, machine tools, or any work in which it is necessary to adjust the position of the illuminating agent.

Cullender's Cable and Construction Co., Ltd., Hamilton House, Victoria Embankment, E.C. At first sight the handsome volume just handed to us by this company appeared like some text book for review. On closer acquaintance, however, it proved to be a very valuable catalogue of the electrical distribution appliances of the firm. It contains over 300 pages of highly instructive and useful data on the subject of distribution accessories. These range from the smallest joint box to feeder pillars and mining and colliery accessories The apparatus is all fully priced, and the descriptions are accompanied by the clearest of diagrams. The cover is marked with the price of 10s. 6d., but the drawings in the book are alone worth that. It is an excellent idea, this combination of technical data and price list, as the time of central-station engineers and managers of electrical undertakings is naturally limited, and to them a publication which is essentially a time-saver must be of immense value. In this respect the foresight of Messrs. Callenders should be rewarded in the proper quarters when contracts are being given out. The book should be in the hands of every main engineer or electrician having charge of any extensive cable system.

Supplement to The ELECTRICAL MAGAZINE,
July, 1905.



Municipal Electricity Supply

COMPLETE REPORT OF THE TENTH ANNUAL CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

WHETHER or no it is expedient for municipalities to engage in the business of electricity supply does not directly concern us here. We have a pleasurable duty to perform in putting on record the developments in this sphere of urban enterprise as typified by the Annual Convention of the Incorporated Municipal Electrical Association, a body of representatives, both of engineers and committees, which consolidates the interests of electricity supply by local authorities. The oldest stations are owned by municipalities and were so from the first. Small wonder, then, that claims to recognition are made for municipal control which in some quarters are regarded as extravagant, not to say arrogant.

The Municipal Idea. — But immense strides have been made since 1895, when the Association was founded, and, although there are many antagonistic forces at work, the prospects before it point to an extension of its prosperity and authority. Despite the influence of vested interests in Parliament, the idea of public control over certain commodities is now deeply rooted in the community, and individual franchise, though abused more often than not by its possessors, can make itself felt should occasion demand.

The Engineering Element. — Want of standardisation, uncertainty of supply, unsettled costs and tariffs: these and other items have tended to disturb the engineering side of electricity supply, with a consequent imposition of checks to rapid progress. It would be saying too much to state that anything approaching uniformity has yet been reached; but there are indications from all quarters of a settlement among the engineers and a consequent desire to tackle new problems. Attention is being paid to getting new business, and thereby improving the load and also the load factor. The engineer though he still has the works at his fingers' ends, can turn from costs and tariffs and illustrate his ability as a commercial man to obtain sales for the commodity he manufactures. The lessons taught by judicious advertising have, however, yet to be learned by many central station engineers, and it is along commercial rather than engineering lines they must expect their works to expand. Engineering may well be entrusted to tried assistants, but the "chief" must aid as much in the development of the undertaking as he does in the extension of plant and mains.

The Committee. — Municipal electricity supply without committees would be like meat without sauce; that is, of course, the councillors' view. The engineer used to, and may still, think otherwise, but in all fairness to the committeemen things may be said to be improving. Engineers are now more tolerant and their brothers in council are less exacting; and if exceptions be excluded, committees are, on the whole, more reasonable. Perhaps they err on the side of economy, but that is the engineer's fault. Neither he nor his undertaking should be too cheap, and his price and that of his *confrères* depends on himself. Committees can be made human if they are found to be otherwise.

The General Outlook. — A broad survey of municipal electricity supply reveals an improved and improving condition of affairs. Consolidation of interests, settlement of differences, and the sinking of grievances are becoming evident every year. Progress may be tardy, but great difficulties have to be surmounted and obstructing influences removed. Sound engineering, sound finance, and sound management are most needed to bring even greater success to undertakings holding good records, while, the same principles applied to less fortunate concerns will also bring good results.

TENTH ANNUAL CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Edinburgh, Glasgow, Aberdeen.

Special Report.

DESPITE the long journey to Edinburgh which faced the majority of the Association members electing to attend the Convention, upwards of 300 engineers and committeemen assembled at the North British Station Hotel for the opening meeting. We were, in fact, agreeably surprised both at the quantity and quality of the attendance. To visit the beautiful Scottish capital would be a new and delightful experience to many, and despite sundry minor drawbacks, the entire party seemed bent on enjoying the outing. From start to finish the Convention must be voted a success, and in this regard councillors will doubtless unanimously agree, because they were given ample occasion to "spout," and were not slow to avail themselves of it.

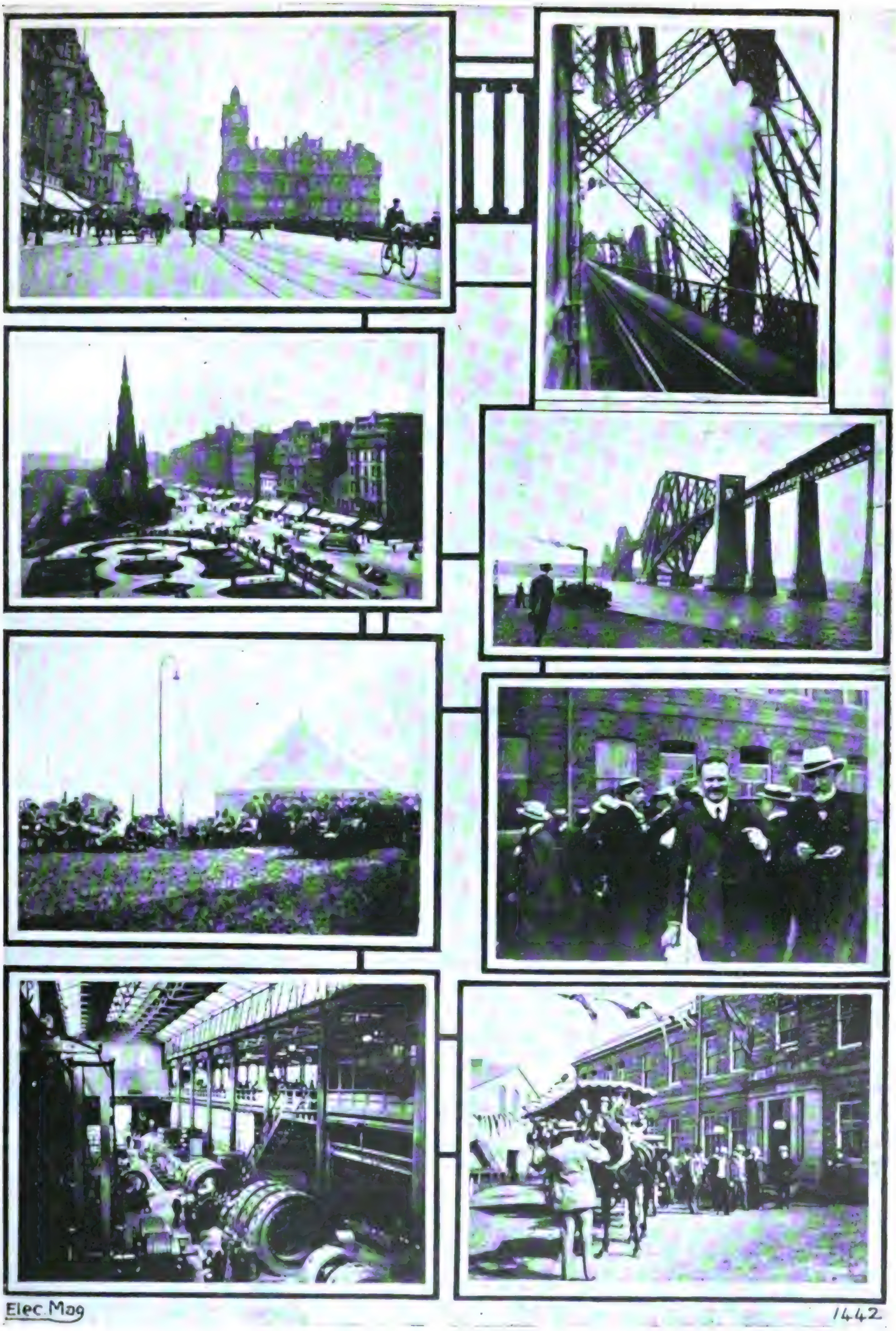
As to the trips and excursions, we got the impression that local pride in electricity departments distorts the views of those responsible for the amusement catering; and visits to power houses, instead of being arranged on the maximum demand system, become fixtures on a flat rate with nothing as discount. Consequently, at Edinburgh, Glasgow, and Aberdeen, engineers constantly stewing in electricity works patiently bore the burden and heat of going round local plants because they could not courteously get out of it. The visit to the Falls of Clyde, on the official programme, for instance, which was ultimately abandoned, might well have been substituted for the brake rides to Dewar Place and Macdonald Road stations of the Edinburgh Corporation. We think it is a pity that engineers should be credited with an overwhelming desire to inspect the stations of their *confrères*, even though these possess more or less interesting features.

Dewar Place station recalled the older ideas of installing plant, and the many small sets seemed almost to have been borrowed from a number of isolated plants for the occasion. Willans engines and Crompton bi-polars were everywhere, and from the switch gallery they had all the appearance of toy units. Ferranti rectifiers, once used for the street arc lighting, are now out of commission, the lamps being run in series across the outers of the network.

At Macdonald Road quite a contrast was presented in the 500kw. and 750kw. units, which line both sides of a spacious and well-lighted engine room. Willans Mather and Platt units predominate, though Siemens and Dick-Kerr have installed later machines and Belliss have put in the last engine. A heavy thunderstorm passing while we were in the station enabled us to find time to inspect the spacious subway in which are run the feeders to the city.

The official welcome to the Association by the Lord Provost in the City Chamber on Tuesday night was a pleasing function which might have been better patronised. Quite aside from the tedium of ceremonial, which in this case was only inflicted on the party a short fifteen minutes or so, the rooms in the building were worth inspecting, and the many old documents, pictures, curios, and weapons, all "incidents" in Scottish history, would have well repaid inspection. Wednesday was Glasgow's day, and its reputation as the former host and entertainer of the Association suffered not a whit on this occasion. The Lord Provost, Sir John Ure Primrose, whose aptness of phrase and fluent diction in reference to complex technical questions delighted his hearers, both welcomed the Association and gave its members sound advice on reserve funds at the luncheon

VIEW OF ENGINE ROOM, DEWAR PLACE, EDINBURGH.
By courtesy of F. A. Newington, Esq.



The North British Station Hotel.

Scott Monument and Prince's Street from Hotel Window.

On the Lawn at Bruce Peebles.

A Snapshot of the Main Shop, Bruce Peebles' Works.

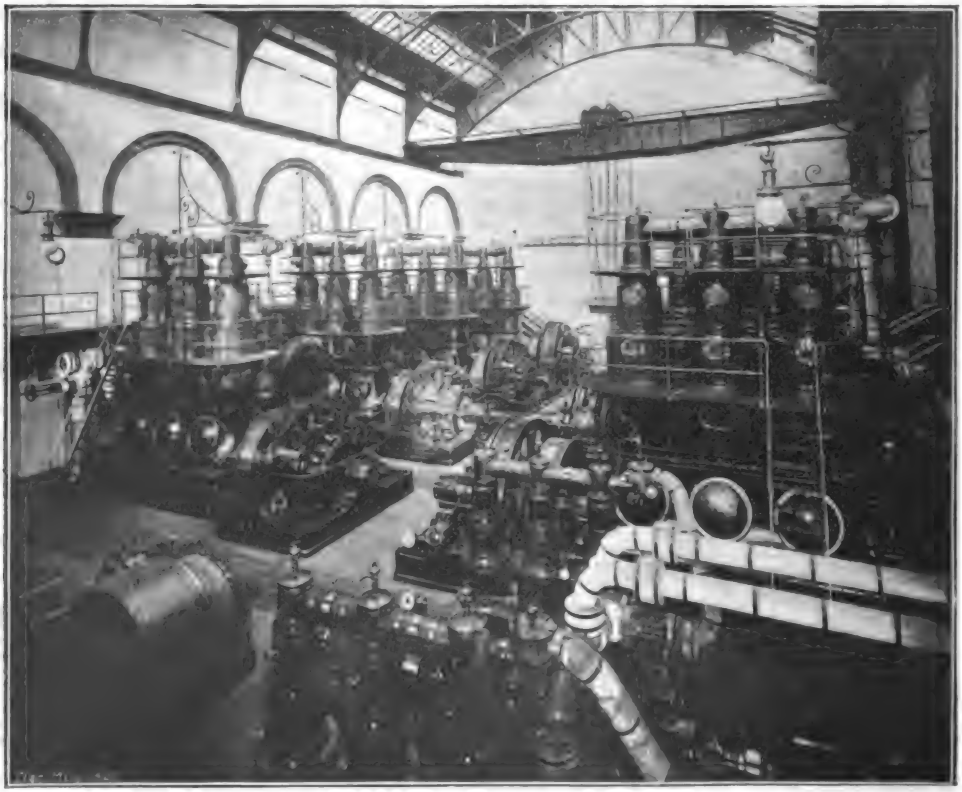
On the Forth Bridge. A Glimpse of the Girder Work from the Train.

The Forth Bridge and Ferry.

Mr. Fedden and his Chairman at Bruce Peebles.

Our Arrival at Bruce Peebles.

in the City Chambers. The splendours of the Banqueting Hall were exchanged for a brake drive through the less attractive streets of Glasgow to the three large power plants operating the trams and supplying energy for lighting and power. Pinkston was first visited, and its monster engines, the Musgraves, Allis and Stewart of a memorable controversy, veritable "cathedrals of power," proved of absorbing interest. The adjoining bay, containing the Mirrlees, Watson condensing plant, looked big enough to accommodate vertical turbines of equal output to the reciprocating a decided attraction, especially at the end, where extension panels, by Witting Eborall, for high tension control where being erected. In the vestibule under the tower was a very complete exhibition of apparatus by the mains department, but time was too exacting, and for our part these had to pass uninspected. We were quickly ushered to St. Andrew's Cross, where, but for the new Siemens-Willans turbo-generator, almost identical plant to that at Port Dundas was installed. Naturally the "baby" unit was the centre of attraction, despite the climb to the



Main Engines and Generators McDonald Road Station Edinburgh.

By courtesy of F. A. Newington, Esq.

monsters in the engine room above. The old switchboard of the man-trap type was found to be replaced by an electrically operated combination by the Westinghouse Company, with bus-bars and switches behind the engine room end wall. At Port Dundas a greater variety of plant was on view, and preparations for the installation of horizontal turbo units were well under way. These are two Willans-Dick-Kerr units of 4,000h.p. each, and they will bring up the station capacity from 12,000h.p. to 20,000h.p. When these are in operation the remainder of the plant will look quite hoary. The switchboard gallery was switchboard gallery involved to reach it. The generator, at any rate, was worth the effort, as it gave the lie to those experts who had no faith in carbon brushes for turbo-dynamos. The brushes were there right enough, and there was no faking.

Messrs. Siemens are to be congratulated in solving a difficult problem by exceedingly simple means. A separate compensating field system with independent iron circuit had been arranged with four poles, giving a flux at right angles to the exerting flux. This keeps down the commutator E.M.F., and as was visually evident produced satisfactory running

A Peep at Pinkston Stacks.
Outside the City Chamber, Glasgow.
A Group at Mirrlees, Watson's.
Mr. Day and Mr. Cramb in Council.
After the Luncheon, City Chamber, Glasgow.
The Morning Meeting in Glasgow Breaking Up.
Port Dundas Station, Glasgow.
Crowding into McDonald Road Station, Edinburgh.

of the brushes. A good long commutator is used with four shrinkage rings. At both these stations the Willans engine predominated, though some sets were coupled to Belliss and Alley and McLellan engines. In the matter of dynamos, the Scotch evidently believe in mixtures, for we noticed the names of B.T.-H., Crompton, Westinghouse, Mavor and Coulson, Bruce Peebles, I.R.G.P., and British Electric plant. From this point the parties were split up. Some returned to the city, others went out to Yoker to see the new station of the Clyde Valley Power Company, while yet a third section were driven to the Scotland Street works of Mirrlees, Watson and Company. We found ourselves among this party and were given a flying view of the main shops of the company, which looked none the less imposing or busy for that. We also had a chance to inspect two 35h.p. Diesel engines running in the engine house. These are used for driving by belt, two small dynamos lighting the shops and for operating the electric cranes. The engines were running very "sweetly," and from the reports of the fuel consumed, we think it was $\frac{1}{10}$d. per h.p.; they promise well for the future. We need hardly remind our readers that crude oil is used.

On Thursday, with the Clyde Falls trip discarded, there was nothing left but the Forth Bridge and Rosslyn. Messrs. Bruce Peebles and Co., Ltd., however, stepped into the gap, and with brakes at the hotel door, buttonholed members rushing out to catch the train for the Forth Bridge. Upwards of two hundred members, with a goodly smattering of ladies, were driven to the East Pilton works, which had been decorated in honour of the visit, and were gay with flags and bunting. *Apropos* of the ride, we were crossing a narrow bridge at the top of a steep bank when our party narrowly escaped disaster. The driver was pinched at the crown of the bridge by a cab, and pulling too near the wall, struck the awning against a telegraph post, bringing the light structure crashing down on the heads of the company in the rear. Happily no one was hurt, and the wretched cabman richly deserved the epithets of the party, which were freely showered upon him.

The main shops of Messrs. Bruce Peebles' works contained much to interest the party, as a quantity of novel designs of apparatus was going through at the time. The motor converters, polyphase locomotive, and duplex traction motors were easily distinguishable by groups of enquiring engineers, and those who found their way into the galleries were well repaid by seeing a new flame arc lamp on test there.

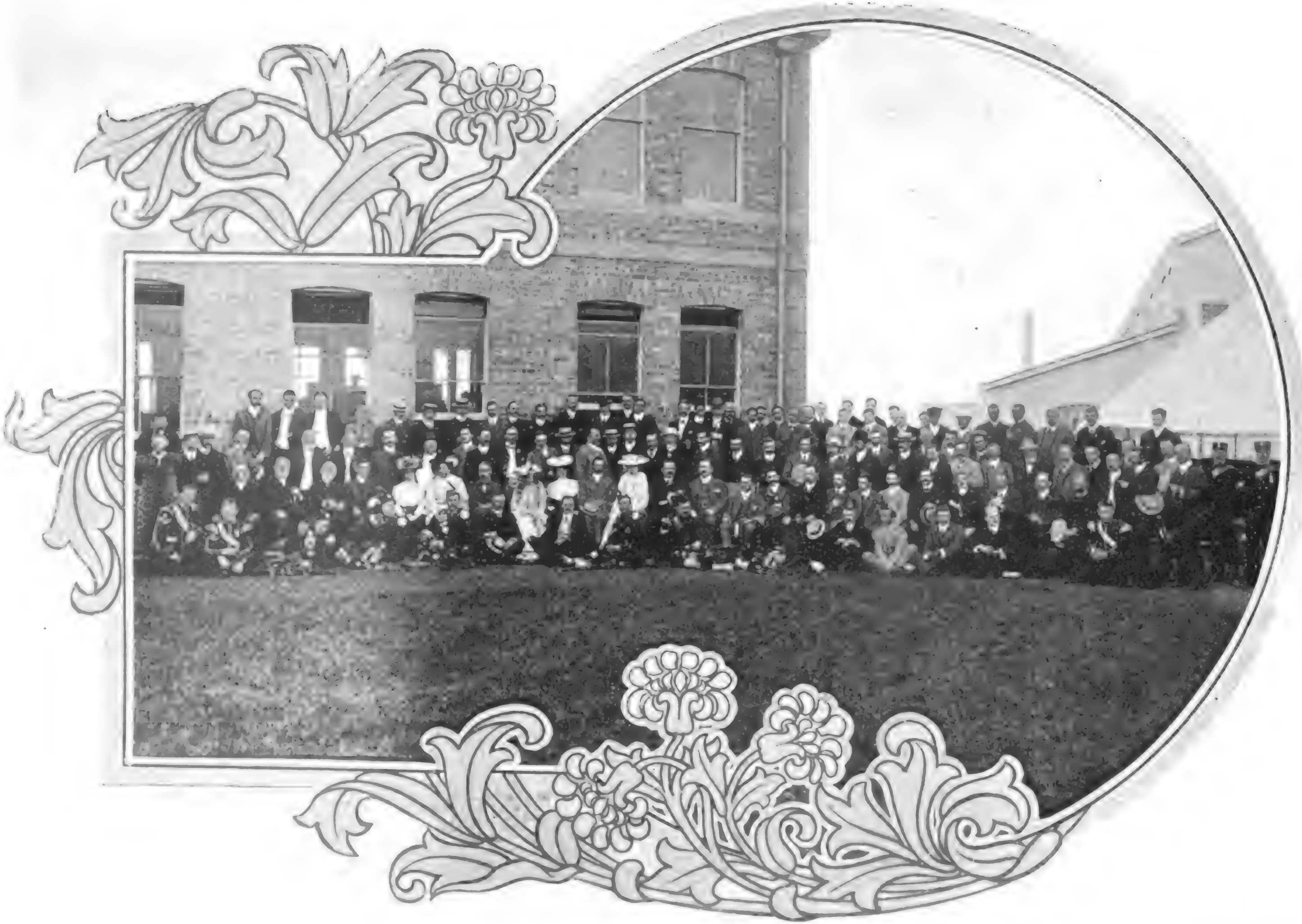
The lamp in question was in the care of the inventor, Mr. Mensing, whom we had met on a previous occasion. He explained the new features of the lamp, which is certainly the acme of simplicity. It has but one controlling solenoid placed above the carbons, which are above the arc and incline towards it at an angle. The downward reflection of the lamp is greatly increased by this arrangement. A single enclosed globe is fitted, and the life of the lamp is considerably extended; in fact, to 150 hours.

Not only were the electrical appetites of the visitors fully catered for, but ample provision was made for feelings perhaps nearer and dearer to the individual heart. In a spacious and cool marquee on the lawn at back of the main offices refreshments were served and the company treated to a skirl on the bagpipes. After being photographed and snapshotting a party of lady typists, who obligingly posed for the visitors, we returned once more to Edinburgh, having enjoyed one of the most pleasant afternoons of the whole trip. It was evident that the splendid reception given the Association at Glasgow was not lost on Edinburgh, which was able to rise to the occasion in an equally hearty manner.

The same evening was fixed for the Annual Dinner, and with this function the proceedings in the South of Scotland were practically brought to a close, excepting, of course, the annual meeting to be held next day. Reference to both of these will be found elsewhere. Being among the party to visit Bruce Peebles' works on Thursday, we decided to inspect the Forth Bridge on the following day, as a goodly number of members had availed themselves of the kind offer of the North British Railway Company to walk over the bridge from Dalmeny Station on the Thursday. We took the trip by ferry across the Forth, and returned by train from South Queensbury Station to Dalmeny. Although we crossed the bridge at a very good pace we managed to get a snapshot of the lattice and girder work *en route*.

Saturday was devoted to "doing" Aberdeen, despite ex-Bailie Kemp's warning at the Annual Dinner that Aberdonians were past masters in the art of "doing" both people and things. An excellent programme for the entertainment of visitors had been prepared, and the forty odd members who had made the journey thoroughly enjoyed the visit.

The party was met by Lord Provost Walker, ex-Bailie Kemp, Mr. J. A. Bell, electrical engineer, Dean of Guild Lyon, Councillors Wallace, Milne, and Lorrimer, and Mr. S. Milne, gas engineer. The Corporation's special white car conveyed the members to the entrance of the £20,000 electric cable subway, and a perambulation through this brought them to the Dee Village electricity works. The Scotch have a partiality for Willans engines, for no less than fourteen of these are installed. There is, however, a newcomer in the shape of a Belliss. The dynamos are a mixed stock, comprising five E.C.C., two Holmes, one Crompton, one Mather and Platt, one Bruce

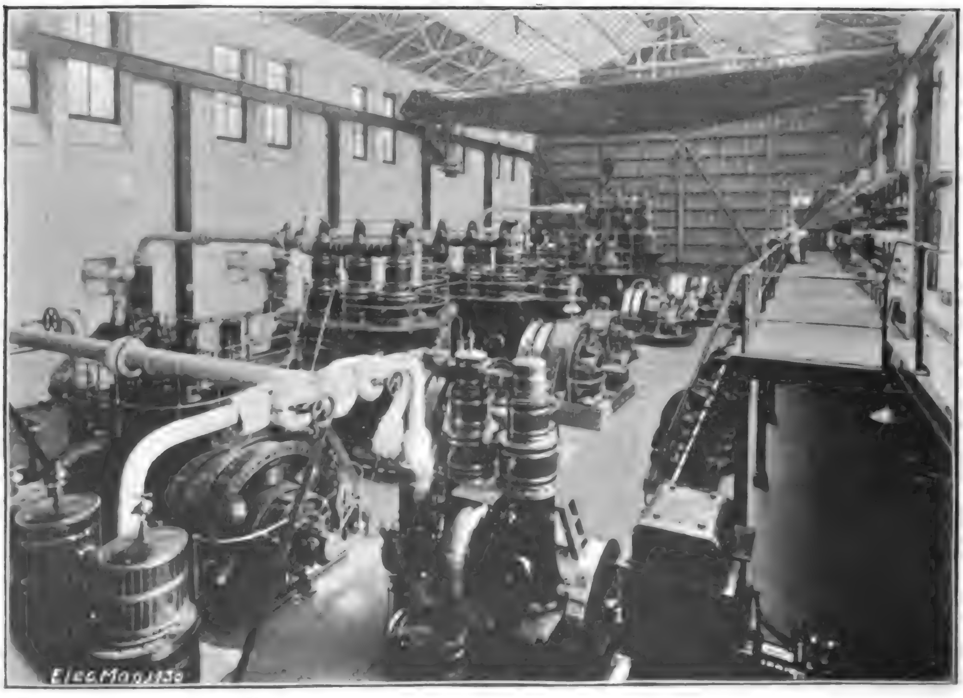


Group taken on occasion of the Visit of the I.M.E.A. to the East Pilton Works of Messrs. Bruce Peebles & Co., Ltd., Edinburgh.

Peebles, one British Westinghouse, one Johnson Lundell, three Mavor and Coulson—these aggregating 3,580kw. Scotch tastes in dynamos have evidently yet to settle down. For the edification of the visitors the breakdown squad turned out on the raising of an "alarm," and set off at high tension on their special repairing car for the scene of action.

The luncheon at the Town Hall was, of course, the event of the day. In the matter of speech making the Scotchman seems to excel, but never so much as in his native town with the flush of local pride upon him. The speeches by Lord Provost Walker and ex-Bailie Kemp supplied all that was needed to make the meeting a conspicuous success. The sentiments they expressed were unmistakable, in both welcoming the Association to the town, wishing its efforts every good, and commending its work in furthering the advance of municipal enterprise. Alderman Pearson and Judge McPherson duly acknowledged these kindly compliments, and had only one thing to regret, that so few members had been able to avail themselves of the generous hospitality so heartily extended by Aberdonians. The departure of the "tail-end" of the members from the northern city brought the tenth Annual Convention of the I.M.E.A. to a close. The arrangements were in the hands of the able and energetic secretary, Mr. McArthur Butler, to whose courtesy on several occasions we are greatly indebted.

Ex-Bailie Kemp, Convener, Electricity Committee, Aberdeen.



View of Main Engine Room Dee Village Station, Aberdeen Corporation.

The Convention Proceedings.

THE members were called to order on Tuesday morning in a large room of the hotel, to listen to LORD PROVOST SIR ROBERT CRANSTON'S words of welcome. Unfortunately, the acoustic properties of the room were far from good, and hearing at the back was somewhat difficult. The LORD PROVOST, in a happy speech, extended the glad hand to the Association on behalf of Edinburgh, and especially so on account of the excellent electricity works run by the Corporation. The face of Edinburgh was her fortune, and local merchants took advantage of the electricity supply to further enhance the natural beauty of the city's countenance. The convener of the Electric Light Committee, COUNCILLOR STEVENSON, backed up the Lord Provost's eulogies of his undertaking with a few figures culled from its history. "Ten years ago we had 450 consumers and an output of 880,000 units, but to-day our consumers number 8,000, and our revenue is £112,000, with an output of 11,000,000 units." A reserve fund of £78,000 had been built up. So prosperous was the concern that the hands

MR FRANK NEWINGTON, M.I.E.E., PRESIDENT I M E.A., 1905 CHIEF ELECTRICAL ENGINEER, EDINBURGH.

of the city treasurer were with difficulty kept off the profits. The greetings were fully emphasised with that indigenous Scotch accent which was to be met everywhere during the Convention (except in the hotel dining-room).

MR. NEWINGTON'S PRESIDENTIAL ADDRESS.

(*Abridged.*)

I HAVE to thank you for the great honour you have done me in electing me your President for this year.

This is our tenth Annual Meeting, and it is interesting to note the increase in membership since the formation of the Association.

In the first year our members were:

Representatives of Committees	30
Engineer Members	48
Associates	36

and now they are:

Committees	148
Engineer Members	159
Associate Members	13
Associates	71

That is, our membership has increased nearly four times during this period. The period for repayment of loans has been very carefully considered, and this Association has come to the conclusion that about thirty years is the average life of electrical plant. There is, however, still no standard period for repayment. Quite recently the Local Government Board has granted loans on what appears to be far too short a term for repayment. This matter will be brought before you at the General Business Meeting, so that some concerted action may be taken.

The methods of dealing with the profits of electricity supply undertakings is still a difficult question. In the event of the general rates not being sufficient to meet the expenditure, it is a very easy way out of the difficulty to take a few thousand pounds of the surplus of the electricity undertaking, and so save an increase in the rates the following year, but this seems to be a short-sighted and dangerous policy, at any rate until the full statutory amount of 10 per cent. of the capital expended has been placed to the Reserve Fund. If electricity were universally used, a contribution to the rates, although undesirable, would then be borne more evenly than under present conditions. The other side say that as any loss would have to be borne by the rates, it is only right that the undertaking should pay something for this security. But is there much in this argument? As a rule the undertaking pays its way after the first year or two. Although the majority of undertakings are building up their Reserve Fund as quickly as possible, still it seems that we are not any nearer to a fixed rule about this than we were ten years ago.

Depreciation of plant is closely connected with the Reserve Fund. If the loans are paid off in twenty-five or thirty years and the Reserve Fund is made up to the full amount, is it necessary to further depreciate the plant? Municipal undertakings in this respect are working under different conditions to companies. Electricity supply companies have a definite number of years, forty-two in most cases, during which they are given statutory powers to supply electricity in a given area, but at the end of that period the

EX-BAILIE WILLOCK. BAILIE BURRELL.
SIR JOHN URE PRIMROSE.
BAILIE STEWART. EX-BAILIE FINLAY.

Taken from Menu at Luncheon given by Glasgow Corporation to I.M.E.A.
(Block kindly lent by Aird & Coghill, Glasgow.

local authority can buy up the undertaking, not as a going concern, but simply at the then value of the plant. Now consider a municipal undertaking. The Capital has to be paid off in from twenty-five to thirty years as a rule. At the end of this period how do we stand? Buildings will still be quite good; the copper in the mains will be of very considerable value even if the insulation is not, and if our machinery has been kept in good order by general maintenance and perhaps by calling on the Reserve Fund in special cases, our successors will have a good business bequeathed to them with a very considerable amount of plant without having to pay for it. The loan having been paid off they will be free to borrow again to replace machinery if necessary. Moreover, if the local authority at any time during the period of the loan or after is desirous of selling the undertaking, judging from towns where the local authority has purchased from a company, they will be able to command a very considerable sum for goodwill. It seems, therefore, that local authorities are very much better situated in this respect than are companies.

There is another side, however, to this question of depreciation which must be kept in view. It would be very unwise to say that the type of machinery in use to-day will also be installed twenty or thirty years hence. But unless some entirely new method of generating electricity is discovered, any improvements that can be made in either steam or gas engines would not warrant the displacement of the present very efficient steam engine. With coal costing about ¼d. per unit (and this figure we are all gradually reaching), enormous economies would have to be obtained with any new method of generation before it would pay us to do away with our present machinery. But we must not forget that we may have to face some altogether new form of artificial illuminant, and therefore it would seem a sound business policy to form a depreciation fund over and above the Reserve Fund in order to meet an emergency of this kind.

In connection with the finance of municipal electrical undertakings, it is exceedingly satisfactory to notice how many more towns are now making a profit, and in many instances large profits, as compared with a few years ago. In the table of costs, published in a contemporary, May 25th, 1905, the number of municipal electric supply undertakings, not including tramways, making a profit, is 115, the surplus being about £436,000. Those showing a loss are 67 in number, the amount being £69,480. Of these 67 towns, 42 have only completed their third year of working. The figures given in the table of costs for a corresponding date in 1902 are 46 towns with a surplus of about £89,000, and 53 towns with a loss of £86,500.

COUNCILLOR A. STEVENSON (EDINBURGH.)

Gas experts have succeeded in very much improving the incandescent gas mantle, so much so that it is now very suitable for the lighting of streets where a large amount of light is not necessary, and where therefore arc lamps would be too powerful. Just at present there does not seem to be any form of electric lamp that can quite compete with the incandescent gas mantle for this purpose. There are some new forms of electric lamps more or less in the experimental stage at present that appear to be very promising as they are exceedingly economical. We may therefore very soon expect to have a lamp that can be used for side street lighting at a less cost than the incandescent gas mantle.

W. W. LACKIE, CHIEF ELECTRICAL ENGINEER, GLASGOW.

During the last ten or twelve years enormous improvements have been made in the manufacture of machinery for generating electricity, but unfortunately very little, if any, advance has been made in the wiring of houses or other buildings for electric light. So-called india-rubber insulation for electric conductors frequently contains from 50 per cent. to 60 per cent. of something that is not rubber at all. The elastic properties of this mixture soon disappear, and it becomes hard and brittle. If there is any moisture in the pipes the insulation fails, and then the house has to be re-wired. The material now very generally used for insulation is not nearly so good, on account of the high price of rubber, as that employed ten years ago. Contractors for electric installation work naturally buy the cheapest material they can, especially as competition is very severe, but as a rule they have no idea of what the insulation is composed, nor have they means of testing it. They trust to insulated cable makers to provide them with material that will pass the official test of the supply authority. As iron pipes are now very generally used for protecting the wiring, a better insulation for the conductors is required than in the days when wood casing was practically the only material used. We do not want to increase the cost of installing electric light, as this would prevent the smaller householders from using it. If possible we should try to make it less costly. A system in which fire-proofed

ABERDEEN'S CABLE SUBWAY—46 CABLES ARE NOW IN POSITION.

cables are used, carried on suitable insulators fixed to the walls or ceilings, should be perfectly good. The insulation of the cables would require to be of high quality, and good workmanship would be necessary, but the cost should be considerably less than with the present system with poor quality material. Re-wiring when necessary would also be an easy matter. The cost of installing electric light is a very serious consideration to the small householder. This is realised by local authorities themselves wiring houses on what may be called easy payment terms.

The present position of supply authorities as regards the power to enforce wiring regulations is vague and unsatisfactory. In the Electric Lighting Acts, and also in most Provisional Orders, there are clauses which may be taken to give the undertakers the necessary powers to enforce good work. But as these are not so definite as might be desired, your council are now considering this matter with the view of asking the Board of Trade to sanction wiring regulations which will, as far as possible, insure the safety of the public from the risk of fire.

The President last year referred to the testing of consumers' lamps. This has been taken up very energetically in Harrogate by Mr. Wilkinson, who has made arrangements so that consumers or contractors can have their lamps tested at a nominal charge. Although testing the lamp when new will not prevent the consumer from using it after its useful life is past, it will at any rate insure that the lamps when new are efficient. This seems a simple way to prevent the consumer buying low-priced inefficient lamps, simply because they are cheap at first. This matter is now being carefully considered by a committee of this council, and suitable rules and conditions are being drawn up which will be issued very shortly.

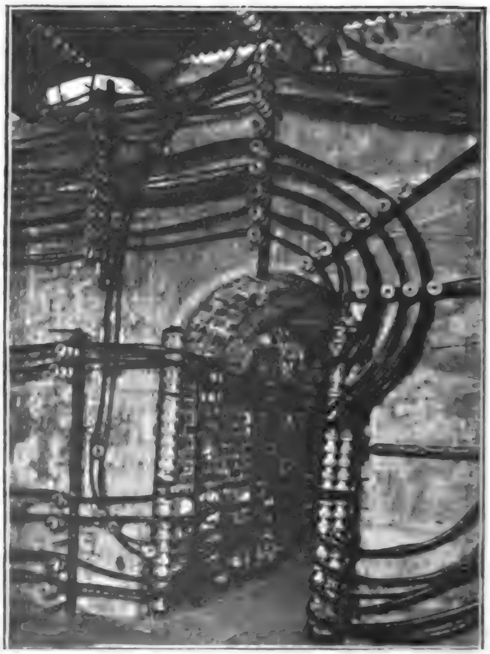
One of the aims of a municipal electrical undertaking is to utilise the machinery during the day-time as much as possible, and therefore electricity for power or heating purposes is sold at a low rate. But there is a weak point in this arrangement. The motors are used during the time of maximum lighting load during the winter months and, therefore, additional machinery must be provided for them. If we can arrange for the motors to be switched off during the two or three hours of maximum load for lighting in the four winter months, extra machinery will not be required, and so a very low rate can be charged This system is just now being adopted in Edinburgh, and is also in force in a few other cities.

J. A. BELL, CHIEF ENGINEER ABERDEEN.

On analysing the consumption of electricity by motors, it is generally found that the load factor is extremely low. The following figures show the average number of hours a day during which the total power installed is used for different classes of work in Edinburgh:

Purpose.	Total H.P. installed.	Full Load. Hours per day.
Elevators	610	.9
Butchers and bakers ..	180	1.27
Printing works	1327	1.52
Breweries	247	1.13
Joiners and builders ..	1057	1.85
Engineering works ..	981	2.08
Laundries	40	2.87
Aërated water works and bottling stores ..	28	3·27

From these figures it is quite certain that the total power used at any one time is not half the



ENTRANCE TO CABLE SUBWAY ABERDEEN FROM CENTRAL STATION END.

power installed, and so the hours per day can at least be doubled, but even then the load factor would not be good. As the cost of generating electricity will be in inverse proportion to the load factor of the motors, this should be considered when fixing the price of electricity for power purposes.

The above figures are not of very much value, because they do not tell us how much of the motor load overlaps the lighting load. In connection with the large Power Bill now before Parliament, a good deal has been said about the diversity factor, but is this not overrated? As a rule, factories shut down at about the same hour, say, six o'clock in the evening, and probably the motors are in use more or less up to the time of stopping. In conclusion, I would suggest that the members of this Association would be collecting very valuable data if they could find out how the motors connected to their system are used during the hours of maximum lighting load in the winter months.

ALDERMAN ROBB (Tunbridge Wells) proposed a hearty vote of thanks to the President for his address, and DR. (now SIR) A. B. W. KENNEDY, F.R.S., seconded it, remarking that though not a member of the Association, he could claim to be its father, as so many of his old boys were numbered in it.

LOAD FACTOR—ITS EFFECT UPON AN ELECTRICITY STATION.

By COUNCILLOR ALEX. SINCLAIR
(Chairman of the Electric Lighting and Tramways Committee, Swansea).

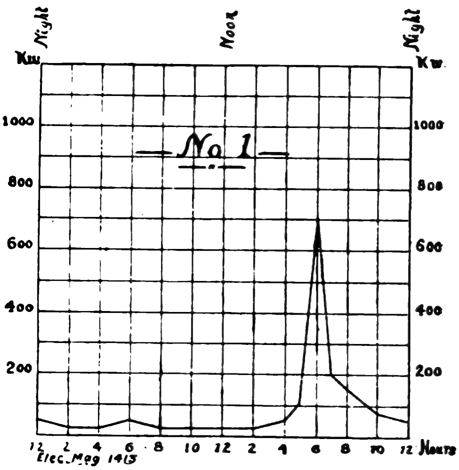
A Paper for Councillors.

COUNCILLOR SINCLAIR.

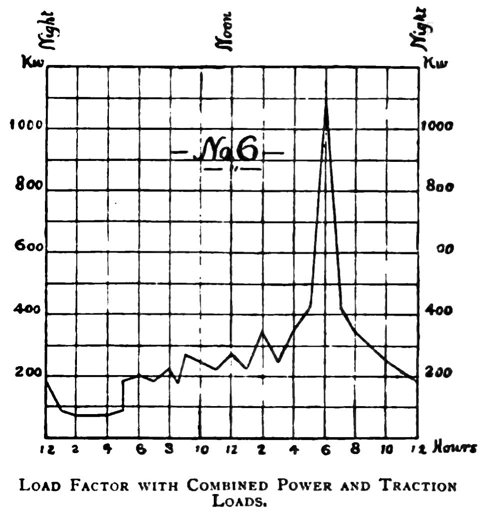
ALTHOUGH lighting was in the first instance the reason for establishing an electricity undertaking, it is generally conceded that this alone can only hope for a certain measure of success. By adding customers who will take energy either for power or other purposes during the hours of light load the load factor is improved, witn a result that the cost of generation per unit becomes decreased. Among desirable customers to assist in attaining this end are: public lighting, power and heat, and tramways, but there are also others of great importance, such as suppiy in bulk, small cottages, &c., but for the purpose of this paper it is the writer's intention to deal only with those enumerated. For simplicity he divides his remarks into two parts, the first dealing with the station itself, and the other with the commercial aspect.

A series of charts was submitted to illustrate graphically the effect attained by incorporating the classes of supply mentioned with the ordinary lighting. The charts were to be regarded as neither in any way typical of any station nor ideal, but simply formed an illustration of what might be done in common practice in a town of 100,000 to 150,000 inhabitants and a station of 1,500 to 2,000 kilowatts. The first and last of these are reproduced as illustrating the influence of (1) a purely lighting load on the station, and (2) a combined power lighting and traction load. The comparison of these effects is sufficiently striking to exclude further comment.

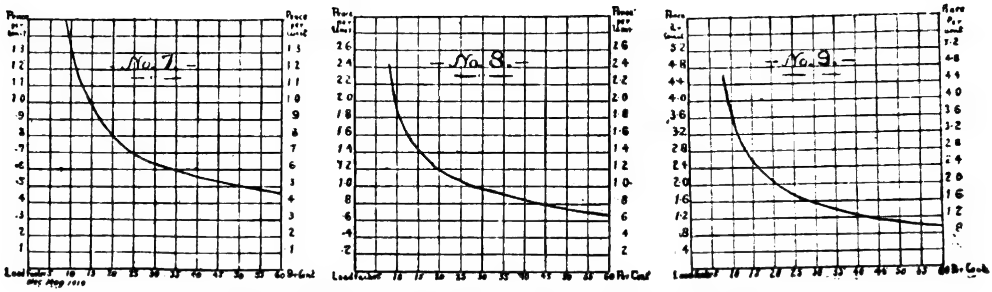
After much study and considerable experience, the author has compileo a series of curves showing cost per unit under varying load factors; these must not be taken as indicative of either the relatively good or the relatively bad, or to the very large or very small stations, nor of



LOAD FACTOR WITH LIGHTING LOAD ONLY



LOAD FACTOR WITH COMBINED POWER AND TRACTION LOADS.



CURVES SHOWING COST PER UNIT WITH VARYING LOAD FACTORS.

any particular one, but may be applied to all, correcting for variations due to locality or other cause. Curve No. 7 is intended to illustrate the works cost under different load factors; the cost per unit in pence can, from this curve, be readily ascertained for any factor from 8 to 60 per cent.; it is made up of station charges for coal, wages, repairs, oil, stores, &c., but as the figures are reasonably within ordinary results it is not necessary to comment thereon.

Curve No. 8 is an effort to depict the total charges, *i.e.*, works cost plus management, rent, rates, taxes, insurance, &c., in pence per unit for factors ranging from 8 to 60 per cent.

In curve 9 will be found the cost per unit in pence under different load factors for total costs plus interest and sinking fund; for the purpose of this curve an average capital expenditure of £120 per kilowatt of maximum demand has been taken and the calculation worked out on the basis of 5¼ per cent. for interest and sinking fund.

Now as to the commercial advantage likely to accrue from improved load factor. For private lighting alone (taking the cases quoted) each unit costs, at 10 per cent. load factor, 3.595d., public lighting alone with 50 per cent. L.F. 1.072d., power alone with 42 per cent. L.F. 1.2d., traction with load factor of 47 per cent. 1.1d., whilst the four combined with a L.F. of 23.14 per cent. costs only 1·835d. or practically half the cost for private lighting alone.

As to the reliability or otherwise of these figures, and assuming for the moment they represent the revenue per unit, they should give on the collective load factor a similar amount as on the individual L.F. For this purpose are again taken the figures of the earlier illustrations, *viz*:—

Private Lighting	613,200	units at	3.595—	£9,185
Public ,,	219,000	,, ,,	1.072—	978
Power ,,	415,000	,, ,,	1.200—	2,075
Traction ,,	916,370	,, ,,	1.100—	4,200
				£16,438

whilst collectively the result is:

2,163,570 units at 1.835d.—£16,502.

It is essential to the cheap generation of electricity to increase the load factor of a station by every possible means, and this can be done by pushing vigorously the different kinds of business enumerated. To sum up, the author would advise first, the increasing of the ordinary lighting load by systematic canvassing, thereby bringing before the notice of probable consumers, in an attractive form, by booklet or otherwise, the great advantages of electric lighting over other forms of illumination. Secondly, public lightings should be extensively used, for the financial position is so improved as to allow energy to be sold at cheaper prices; Edinburgh and Glasgow may be cited as typical examples of the fruitfulness of this supply. He also is of opinion that this point does not always receive its due consideration by electric lighting committees, and where it is tried, more or less extensively, its progress is often throttled by the charge per unit being too high, thus affording adverse comparison with other forms of street illumination. Thirdly, and on this point he lays particular stress, that great hopes may be held out for the future of stations by dispensing power on a large scale to small users at cheap rates. There are many towns where there are small users of power, such as timber yards, printing establishments, machine shops, &c., at present using steam or gas driven plant, where electricity would prove more efficient and economical. Where powers are held for the hiring out of motors, this class of consumer is making great headway, because many view with much apprehension the scrapping of their present plant and substituting electricity with what they think the possibility of failure; when they know that by hiring a motor their liability—should they wish it—ends with the year they are more prone to enter into a trial of what they consider to be more or less an experiment. The experience in this direction in Swansea has been to add very largely to the business, and to some extent to account for its successful running; in two years we have improved our load factor from 12 per cent. to nearly 18 per cent., and the author may here add that it is to this circumstance the title of his paper owes its origin. Lastly, with regard to traction: it is not many stations which are so fortunate as to have this valuable asset, but the experience of those having such a load is quite sufficient to demonstrate its help in producing excellent results.

There is another feature. A uniform price per unit for electricity cannot be fixed, but must depend on the nature of the supply, *i.e.*, quantity and load factor. The maximum demand system meets the requirements of the case, but its explanation is so complicated to the ordinary individual that he either cannot or will not try to understand it. If a system simple in itself could be arrived at whereby a customer's load factor could be readily and easily ascertained, his charge per unit could then be regulated by

a discount on its rated price. By some such means the ordinary customer, usually a man of business, would be appealed to because he would readily accept the situation if made aware that his account is subject to a discount on the quantity (as gauged by his load factor) of energy he uses, whereas when confronted with the complex explanation of the maximum demand, he is amazed—always confused—and if his bill be high, never satisfied.

Discussion.

Mr. J. F. C. Snell (Sunderland) took exception to Mr. Sinclair's load factors for public lighting and tramway supply, his experience showing that figures of 20-24 per cent., and not 50 per cent. in the first case, and 28 per cent., not 42 to 47 per cent., in the second, were nearer the mark. Again, he found that £60-£70 per kw. installed was the average, and not £120 per kw. demanded, as stated. He agreed that the consumer was rarely satisfied with the maximum demand system, and then mentally pictured its disuse in practice when electricity was stored like gas. Sunderland were faced with competing gas at 1s. 5d. per thousand, and only by the addition of shipyards and large works were they able to improve the load factor. A trifling 500,000 units were sold last year for power, but this moderate figure (which made some engineers' mouths water) would be increased to 7,000,000 this year, and 10,000,000 to 11,000,000 next. Purely as an illuminant electricity could not hold up against gas. Mistaken notions existed regarding the permanence of improved load factor obtained by the addition of trams. Engineers and chairmen should be impressed with the fact that as the ratio of the general to the traction load decreased by additions to the former, the load factor often receded to a point below that obtaining with the former lighting load. Bailie Willock (Glasgow) naturally disagreed with Mr. Snell in the matter of flat rates because they encouraged the long hour consumer in Glasgow with special discounts, and had realised the advantage of so doing. Glasgow asked 1½d. per unit for 1,200-1,300 hours, and afterwards ¾d. per unit, and one large consumer was able to average ⅞d. per unit. There was a stipulation, however, that manufacturers should not take supply between 4 and 6 in the evenings of October, November, and December. Mr. Faraday Proctor (Bristol) then asked for the basis on which the curves were constructed, as they might, if authoritative, be generally referred to by engineers. Maximum demand was right enough in principle, but it should generally regulate the price according to the demand of a class of consumer instead of that of individual consumers. With overlapping loads, the manufacturer taking power supply could not be expected to shut down for two hours at any time, and the suggestions of Glasgow in this respect were very surprising. Mr. H. Boot (Tunbridge Wells) was the next to express surprise, this time at Mr. Snell's avowed dissatisfaction with the maximum demand system. In Sunderland there was no flat rate, as power and light were charged at different rates. Demand indicators could be calibrated for load factor, and all were agreed that load factor should fix the tariff. His experience of public lighting gave load factors exceeding 20 per cent., and where the "parish lantern" was not called upon, and the hours of burning averaged ten per day, 40 per cent. would be the load factor obtained. Mr. Boot was hardly in his seat when a voice at the back of the room announced its intention of being heard by repeating its owner's name and place. The audience sidled round and gave hearing to Councillor Bussey (Poplar), who had some startling suggestions to make. Local authorities should link up their stations and fight the common enemy, and so help each other. This, of course, did not directly concern the load factor, but the councillors all seemed pleased, so their colleague proceeded. London, he went on, was not Glasgow, and works would shut down for the convenience of no supply authority, so that Bailie Willocks' scheme would not work in the Metropolis. This further reference brought that worthy to his feet again, to inform the gentleman "from Popular" that works were not asked to shut down, but either to take no power during the winter hours mentioned or to pay the full price during the two hours of winter peak. Councillor Camson (Erith) also had something to say, and then Councillor Sinclair briefly replied. He bowed to Mr. Snell's superior experience of street lighting load factors, but knew of many cases of all-night street lighting; as to load factors, his figures were mostly illustrative, but he thought Mr. Snell's figures too low and his own too high in the matter of tramway load factor. The basis of his curves was to be found in his notes, but not having these he reserved further reply for the Proceedings. With a rebuke to the man from Popular, for running off the line, he thanked the meeting for its tacit acceptance of his paper.

STREET LIGHTING.

By E. E. HOADLEY (Chief Electrical Engineer, Maidstone).

E. E. Hoadley.

The three chief points to be borne in mind by an engineer who is trying to get this street lighting business into his own hands are as follows:

1. That the light given shall be superior, or at least equal, to the existing lighting in the streets.

2. That the cost to the ratepayers shall be very little, if anything, in excess of that already paid.

3. That the business shall be done at a profit to the electricity works.

To attain these three conditions simultaneously is by no means an easy matter in towns where, as in Maidstone, gas is exceedingly cheap and the gas company is pushful and enterprising; however, the problem is by no means insoluble.

Maidstone was, the author believes, practically the pioneer of street lighting with Nernst lamps, and a good deal of trouble was taken in experimenting with the various types before anything like a standard was arrived at. The Nernst lamp, which is simply the principle of the gas mantle applied to electric lighting, is made up in several forms. The "A" type, with a vertical glower, or light-giving filament, is made to take either ½ or 1 ampere at pressures varying from 100 to 250 volts. The ½-ampere lamp at 230 volts giving about 75c.p. has so far proved by far the most satisfactory in Maidstone. The "B" type is a smaller form, fitting into an ordinary lamp holder, and having a horizontal glower; this the author originally hoped to use, as it will give from 32 to 35c.p. and seemed to be just the lamp required at the time. However, it had to be given up for reasons set out hereafter. The "C" type or "Luna" lamp has a horizontal glower fixed close up to a white porcelain backplate; and the "D" type is a "B" type lamp enlarged and improved, giving about 75c.p., with a consumption of about 110 watts.

Experiments in street lighting and tests have been made in Maidstone with examples of all these various types of lamps, with the following results:—

The tests were made to determine, firstly, the average life of the burners, secondly, the effect on the life of variation in voltage and of vibration; and so far as the results of these tests prove, both with the "A" and "B" types, very little difference in the life was observed either with a voltage rise of nearly 4 per cent. or in lamps exposed to a considerable amount of vibration.

The following results were obtained with "B" type:—

230-volt lamps.

1. Failed at 555 hours.
2. Failed at 1,494 hours.

3, 4, 5, and 6. Still burning at the end of 1,800 hours.

Average burning life, 1,543 hours, assuming the burners to be useless at 1,800 hours.

235-volt lamps.

1. Failed at 1,675 hours.
2. Failed at 598 hours.

3, 4, 5, and 6. Still burning at the end of 1,800 hours.

Average burning hours, 1,580 hours.

240-volt lamps.

1. Still burning at end of 1,800 hours.
2. Failed at 707 hours.
3. Failed at 824 hours.
4. Still burning at the end of 1,800 hours.
5. Failed at 476 hours.
6. Failed at 411 hours.

Average life 1,004 hours.

The lamps have been taken as burnt out at the end of 1,800 hours, as although the lamps were still intact, the candle-power had very considerably decreased.

Some of the "B" type lamps were put up in the streets, and the illumination measured at various distances from the post with a "Trotter" illumination photometer. The average results obtained with a well-designed reflector were as follows:—

10ft.	15ft.	20ft.	30ft.	40ft.
.048 c.p.f.	.03 c.p.f.	.017 c.p.f.	.008 c.p.f.	.004 c.p.f.

On the above results a great many of these ¼-ampere "B" type lamps were put up in Maidstone, and for a short time the results were satisfactory, the general illumination competing very fairly with that obtained from a single gas mantle in average condition. After a short time, however, it was found that the candle-power of these small lamps fell away very considerably in some cases, and in others hardly at all, with the result that as soon as the burner began to deteriorate it could not hold it own with the gas mantle, and people began to grumble. These lamps have now all been replaced by the ½-ampere "A" type lamps. In the case of the ½-ampere lamps it was found that better results were obtained by using a 220-volt burner and a 20-volt resistance on a 230-volt circuit.

The author has some 350 posts at the present time, most of them having a ½-ampere lamp rigidly fixed and suspended from a swan-neck at the top of the existing gas column, the burner being about eleven feet from the ground, each lamp being housed in by the upper part of a special reflector which is used to get a better distribution of the light; clear glass globes are used, the general public preferring brilliancy to good distribution, although a good many prism globes were used at first. The "A" type lamp, however, has been in use at Maidstone for about three years, and during this time the life of each individual burner has been kept very accurately, and from the results obtained from a good many hundreds, it is found that the average life is 676 hours, and this has somewhat improved lately.

Wet weather exercises a deleterious effect on the burners, which have to be replaced much oftener during a spell of wet weather than during an equal period of fine weather. The author would like to hear whether this has been found to be the case elsewhere, and whether anyone can offer a reliable explanation.

The average illumination results obtained from a ½-ampere "A" burner with a well designed reflector are as follows:—

10ft.	15ft.	20ft.	30ft.	40ft.
.14 c.p.f.	.06 c.p.f.	.03 c.p.f.	.014 c.p.f.	.007 c.p.f.

and these figures compare very favourably with many results taken from a single gas mantle in good average condition throughout the town.

To sum up, the greatest fault with Nernst lamps is their want of uniformity. This is most apparent in the life of the burners, as, although the average life obtained in Maidstone is 676 hours, yet they have had many burners in use for over 1,000 hours, and several between 2,000 and 3,000; equally they have had many which have failed before they have reached 100 hours burning. This want of uniformity is also noticeable in the way in which the candle power falls off: some burners do not appreciably drop for quite a long life, while others lose a great deal of their light-giving properties in a very short time, and will then last in this condition for a long while.

These remarks finish all the author has to say on Nernst lamps themselves, and he would like to now consider the three problems which confront the station engineer before he can get the street lighting into his own hands. Firstly, to give a light at least equal to that given by the ordinary gas mantle. A ½-ampere "A" type

lamp at 230 volts will give a degree of illumination superior to that given by a gas mantle, both when measured by an illumination photometer in the streets and, what is far more important, when judged by the eye of the general public. This point having been settled, there remains the two more important ones, namely, that the cost shall not be greatly in excess of the cost of gas lighting, and that the electricity supply works shall get a profit out of the business.

Firstly as to the cost of lighting. The annual cost per post for a gas lamp having a single mantle, varies from £3 to £4 as a general rule, inclusive of trimming and maintenance charges; £3 10s. per annum is an average figure. These gas lamps are generally placed at distances apart varying from 40 to 50 yards; thus the cost of lighting a mile of street will vary from £122 10s. to £154 accordingly. An equally illuminated street can be got by means of ½-ampere Nernst lamps placed at a distance of 55 yards, although in Maidstone, as the existing gas columns are used, they average 50 yards.

The lamp having a 220-volt burner and a 20-volt resistance on a 230-volt circuit requires 390 B.O.T. units during the year, and has actually cost 9s. for renewals of burners, resistances, &c., 10s. for lighting, and extinguishing, and cleaning; interest and sinking fund charges calculated at 6 per cent. on £6 absorb 7s. 6d., repairs and maintenance of fuses, &c., have actually cost 2s. 6d. per annum, thus leaving £2 1s. for the 390 units of electricity consumed, or 1.3d. per unit; a total of £3 10s.

Maidstone has about 350 posts to be maintained, spread over practically the whole of the town, and each post is supplied from the ordinary distributing mains and has its own switch. There is a staff of four lads, who do the whole of the repairs and renewals of burners, &c., cleaning, lighting, and extinguishing. The switching on is done in from fifty to fifty-five minutes, and the switching off in just over the hour, which are the times specified by the Highways Committee. The actual cost of conversion of a lamp, including the post purchased from the gas company for £1 10s., the swan-neck and fitting £1 19s., the Nernst lamp, globe, wiring, cable, excavation, making good, is about £6.

Having shown that the light given by a ½-ampere lamp is somewhat superior to that given by the ordinary single mantle gas lamp, and that the cost to the ratepayers per post need not be more than that already paid for gas lighting, at which price energy is to be supplied at 1.3d. per unit, it remains to show that at this low price energy can be supplied at a small profit to the electricity department. This street lighting business is a very desirable one to obtain, for, first of all, it is a load that is absolutely constant for ten hours out of the twenty-four averaged throughout the whole year: this means a 40 per cent. load factor on a perfectly steady load. Street lighting, provided it is well done, is a good advertisement, and will lead to mains being laid in streets where, otherwise, they would not be laid, at least until some time later.

The author's calculations and experiments were made on a basis of 350 ½-ampere lamps, or exactly 37 kilowatts; now the extra expense to the electricity works is made up of interest and sinking fund charges on the value of the 37 kilowatts of our undertaking, which, in the case of Maidstone, means £147 12s. per annum, and the extra cost of generating the extra 135,050 units required per annum for these lamps.

Before deciding the matter, the author made some very careful experiments lasting over six weeks to determine what was the actual cost of generating these extra units, bearing in mind the fact that stand-by and up-keep losses must occur whether they supplied the street lighting or not; thus the author contends that for this purpose it is only necessary to take into consideration the cost of coal, oil, waste, stores, &c., and repairs. From his experiments this totalled up to .6d. per unit generated, or allowing a 20 per cent. loss between the switch-board and the lamps, it amounts to .75d. per unit; this, with the capital charges, makes up 1d. per unit, leaving a profit even after allowing for office expenses, &c., which are exceedingly small, as there is only one account to be made out, and no trouble at all in collecting it.

Reversing the position generally the author considers the Nernst lamp, although still far from perfect, to have been the saviour of the side-street lighting business for the electrical world; the chief improvements he would suggest in its manufacture are: that the burner should be made a more mechanical job, and that the actual filament when broken should be capable of easy replacement by the user at a cost of a few pence, instead of, as at the present time, the whole burner, including the heating coil and its supports and connections, being thrown away, at a cost of nearly 2s.

So far as his experience with the "D" type lamp goes, the author is inclined to think that this will be the most useful type for street lighting, as up to the present, beyond burners going, he has not had a single failure due to resistance or cut-out troubles, or from bad insulation in the lamp, and it is much more easily dismantled and put together than the larger and earlier "A" type, and is only half the price.

The ideal lamp for the lighting of the less important streets will, I think, be found eventually in a small flame arc lamp taking about 100 watts, and having a magazine feed so that it will burn for some sixty or more hours without attention. The manufacturers who first produce a reliable lamp of this description, or something of equal efficiency, will reap a rich harvest.

Discussion.

Engineers and councillors have diverse views on street lighting, and the discussion accordingly glistened with many facets of opinion, reflecting every aspect of the question. It is doubtful which of the two parties outshone the other, for both were well in evidence.

Mr. G. Wilkinson (Harrogate), opening for the engineers, first complimented the author on lighting most of his thoroughfares instead of the meagre 5 to 10 per cent. of the street mileage, with which less fortunate engineers had to be content. The Nernst lamp was their best weapon to meet gas; but why go to Germany for it? As a monopoly in German hands, necessary improvements could not be made, and until

patents expired, the lamp would remain defective. In converting from gas, the interest and sinking fund charges on the capital expended for gas fittings should be paid by the annual saving on the electric lighting, and he had high hopes of accomplishing this. Street lighting should be on separate mains, and not the network, for three reasons:—(i.) Joints were fewer, (ii.) lamps could be staggered, (iii.) cost of lighting and extinguishing reduced. At Harrogate, extinguishing at 12.30, street lighting costs were reduced almost to the cost of lighting and extinguishing. Incandescent gas averaged 45s. per lamp per annum when renewals and lighting and extinguishing were reckoned. Mr. Wilkinson then startled the audience by advocating the use of spare plant and scrapped transformers for street lighting. Obviously he was thinking of those unfortunates having the latter articles on hand. Separate mains then gave all that could be desired, but for emergencies "safety" lamps were to be erected in the main thoroughfares, and connected to the network. COUNCILLOR STEVENSON (Edinburgh) then started operations for his side by pointing to the lights of Edinburgh. They had 1,000 arcs, and charged the Street Lighting Committee cost price, or £10 15s. per 10-amp. arc per annum, though a further 200 60-hour lamps had recently been charged at £9 10s. each. Experiments with Nernst lamps had resulted in a successful arrangement being made with two ¼amp. lamps in one globe, one lamp being put out at 12 o'clock. The cost of conversion was 37s. 6d. per lamp, and current, burners, and attendance amounted to £2 15s. 1d. For incandescent gas, as supplied at Edinburgh at 2s. per 1,000 cubic feet, the cost per lamp was £2 4s. 1d., so they were practically on a competitive level with gas. Previously the Gas Commissioners had the side-street lighting in their own hands. MR. T. P. WILMSHURST (Derby) could speak feelingly for the engineers, because he had five or six miles of incandescent electric lighting to supply. He also spoke strongly on the subject of the flame lamp, and severely harangued the British lamp-makers for their dilatory ways. Mr. Hoadley was courageous in erecting 350 lamps, but success seemed to him to hang on the large revenue obtained per lamp, the average figure derived being about 30s. The makers of Nernst lamps then received a wigging for their extravagant claims for their lamps, and want of ingenuity regarding their faults. His experience had proved most discouraging. Lamps had short life, were defective on certain voltages, were badly made, and, in cases, wanted twenty minutes' start before lighting up. A parting shot was taken at Mr. Wilkinson, whose spare plant heresies and cheap opinion of street lighting were to be deplored. Was not street lighting their best advertisement?

The case for the councillors was then resumed by ALDERMAN F. SMITH (Liverpool), but he was no advocate of electric street lamps, naturally, because in Liverpool they used incandescent gas; and JUDGE MCPHERSON (Edinburgh) could only expatiate on what the future might hold. Consequently, nothing remained than for the engineers to take the sticks. MR. HAYDN HARRISON, who had failed twice to "catch the speaker's eye," delivered his opinion of measurements of candle power in testing lamps, stating that the initial rating was far too high. 2,000c.p. arcs were talked of, but this figure was not realised on the pavement. Candle power feet should not be the measuring unit, but just candle power, because everybody understood that. Attendance was an important item with lamps, as, in his experience, considerable loss resulted from dirty globes. "A mon fra Sheffield," MR. S. E. FEDDEN, then recounted his gloomy experiences of futile efforts to enlighten his committee; but they would have none of his electric street lighting. Nernst lamps evidently don't do well in Sheffield, for Mr. Fedden, with "B" type lamps, could only get 13 to 15c.p. out of lamps for which Mr. Hoadley claimed 30-32, and even this figure dropped to 7.2 in about 700 hours. "D" lamps only survived 381 hours, and yielded only 34c.p., as against 75c.p. claimed. Street lighting was not a matter of candle power, but appearance; at least, that was how the public regarded it. Streets in Sheffield looked well lighted, but objects in the centre of the road were not visible. With flame lamps he got good results compared with incandescent gas clusters, the latter giving but 700c.p. for 2,700c.p. for the former. Osmium and tantalum lamps had also come under test, and the latter was most promising. A number were being put up at Sheffield, with double fittings, for 200 volts. MR. C. H. CORRINGHAM quoted the experiences of Darwen and Motherwell, where even the gas engineer admitted his inability to compete with the Nernst lamp. A street lighting load was of greater value in the South than in the North of England. ALDERMAN SMITH (Barrow-in-Furness) soundly trounced his namesake of Liverpool for his views of street lighting by electric lamps, clinching his argument by comparing Liverpool with Edinburgh. MR. HOADLEY's time for reply had been filched by other speakers, so that he will send it in to the Journal.

NOTES ON COSTS AND TARIFFS FOR ELECTRIC SUPPLY.

By HAMILTON KILGOUR (Chief Electrical Engineer, Cheltenham).

HAMILTON KILGOUR.

To every student of the relation between costs and tariffs the question, "On what do costs of supply mainly depend?" will inevitably present itself at an early stage; and a knowledge of the correct answer, together with a proper understanding of all that the answer connotes, is an essential preliminary to any further (useful) study of the matter. The correct answer to the foregoing question is "Costs of supply depend, in general, almost entirely upon the liabilities undertaken, and but little upon the actual supply given."

The liabilities undertaken are two-fold in character, since acceptance of anyone as a customer renders it obligatory to provide the necessary plant, mains, &c., for giving him supply at the greatest rate he chooses to name in his application, and also to so run the plant that the customer may have supply as and when he requires it—subject only to his not exceeding the rate of supply applied for as a maximum.

The capital expenditure upon an electric supply undertaking is, of course, absolutely determined by the total liabilities undertaken, or thought to have been undertaken, by the acceptance of customers; hence all annual charges upon capital, whether compulsory or optional, are similarly determined, and are quite independent of whether supply is, or is not, actually given to customers; the compulsory annual charges are those for interest and sinking fund, and the optional those for insurances in respect to property.

The revenue expenditure* of an electric supply undertaking, or its annual cost as a going concern, is obviously divisible into two distinct parts, viz.: that dependent upon the liability undertaken to give supply as and when required by the customers, and that dependent upon the extent to which customers avail themselves of their opportunities for taking supply; these two kinds of costs are often called the "cost of getting ready to give supply" and the "running cost" respectively, and the former plus the annual charges on capital is usually called the "stand-by cost." No one of these three terms is very aptly descriptive of the cost to which it refers, but, pending agreement as to a more appropriate nomenclature, it will be convenient to employ them.

The "cost of getting ready to give supply" clearly includes all costs of distribution, of meter reading and maintenance, and of management (in fact, all costs except those of rates and taxes and of labour and materials employed at the works), since these solely depend upon the number and kinds of customers connected, and upon their topographical distribution; it is indisputable also that a part of the works cost is due to the undertakers' obligation to have an adequate quantity of machinery running and an adequate number of men on duty at every moment of every day.

The usual method of ascertaining the average value of the "running cost" per unit generated is to subtract the total works cost of the six light load months from the total works cost of the six heavy load months, and to divide the remainder by the difference in the numbers of units generated in these two periods; not infrequently and more properly, as appears from what has been already stated, engineers take for this purpose the costs of coal and water alone instead of the total works costs. Each of these two methods will usually give too large a value for the "running cost" aforesaid, in spite of the fact that in most works plant is run under less economical conditions (*i.e.*, at lower average plant-load-factors) during the six light-load months than during the six heavy-load months.

In a modern works with fairly large units the average value of the "running cost" per unit generated should not exceed one-fifth of a penny, unless the circumstances are peculiarly adverse. At the Cheltenham works, which have been running for more than ten years, and which have rather small units in consequence of both alternating and continuous current supply being given, the average value of the "running cost" per unit generated in a certain year was 0.25 pence according to the second method of estimation described, and 0.23 pence according to the third; the author believes the latter value to be the more nearly correct.

The works "cost of getting (or keeping) ready to give supply" during a particular period is, of course, the difference between the total works cost for that period and the total "running cost" of the energy generated therein; in general, it will be found that the ratio of the works "cost of getting ready to give supply" to the total works "running cost" for any year ranges from about three to one for a bad load-factor and a small output, up to about one to one for a very good load-factor and a fairly large output.

The annual charges against an undertaking for rates and taxes are totally different in character from any of the costs and charges previously considered. Both rates and taxes depend on the actual, or—as the case may be—the presumably possible, trading results, and should be regarded as first charges upon the profits rather than as elements in the cost of working: for this reason it appears not merely convenient but also correct to take no account of them when considering costs—they have, of course, to be allowed for when settling tariffs.

With reference to the undertaking as a whole—and so far this aspect of it has alone been considered—the conclusions arrived at may be summarised as follows:—

1. The total annual costs are divisible into two distinct parts:

(a) "Stand-by costs," or costs entirely dependent upon liabilities.

(b) "Running costs," or costs entirely dependent upon the quantity of energy actually generated.

2. The profits of the undertaking are subject to an annual charge for rates and taxes, and should, therefore, be at least sufficient to defray this charge.

In general it is quite impossible to ascertain precisely the actual cost of the supply given in any particular year to any particular customer. If, however, the customers be grouped into a few distinct classes, each with well defined characteristics in respect to the liabilities of the undertaking towards it, and different supply costs of the different classes can often be approximately ascertained, and a tariff, or set of tariffs, can be determined which will ensure that each class pays its supply cost plus the same percentage. The tariff for each class may take the form of a flat rate, which has the great advantage of simplicity and the great disadvantage of discouraging the profitable and encouraging the unprofitable customers, or of a sliding scale based, for

* Exclusive of that incurred for, and reimbursed by, customers on account of materials and labour supplied for their installations: this expenditure includes that for carbons, trimming, &c., of street lamps, which are virtually installations belonging to the Public Lighting Authority.

instance, on either the Hopkinson or the Wright system.

Every method by which it is sought to divide the total annual costs of an undertaking equitably among certain different classes of customers must comprise three different operations, *viz.* :—

1. The allocation of the energy wasted in distribution, and of the energy used in the works, offices, &c., between the different classes of customers so that the number of units generated for each class—and, therefrom, its total "running cost"—may be known;
2. The allocation of the total capital expenditure between the different classes of customers so that the annual capital charge proper to each may be known;
3. The allocation of the total "cost of getting ready to give supply" between the different classes of customers;

and, when these allocations have been more or less satisfactorily made, it remains to allocate the annual charge for rates and taxes.

Now, each of the three operations mentioned may be regarded as comprising two subsidiary and distinct operations, viz., the allocation of energy wasted or used, or—as the case may be—of cost incurred, specifically in connection with a particular class of customers, and the allocation of energy wasted or used, or of cost incurred, without special relation to any particular class; the former kind of allocation is simple and generally quite easy; the latter is very difficult and sometimes exceedingly laborious.

Until comparatively recently the author thought* that it was desirable to attempt an equitable allocation of the total costs of an undertaking between such different classes of customers as those taking electric supply of private lighting, motors, public lighting, and traction; also that by comparing the allocated cost of each class with the income derived from it some useful conclusions might be arrived at; he has since become convinced, however, that equity has nothing to do with the matter.

The proper way of viewing the question is to recognise that the total annual costs of an undertaking include a general establishment charge besides the actual annual cost of the different classes of customers—the actual annual cost of any given class of customers being defined as the amount by which the total annual cost of the undertaking would have been less had the class of customers never existed and had no provision, therefore, been made for giving supply to it. Not merely the actual annual costs of the present, but also those reasonably probable in the future, should be considered when settling tariffs, and the reference is to day-load (motor) customers.

Just as the total annual cost of an undertaking is influenced mainly by the liabilities undertaken for giving supply as and when the customers generally require it, so, in regard to any particular class of customers, the cost of supply is mainly determined by the liabilities assumed with respect to it, and it may be well to briefly discuss now some of the characteristics in regard to liabilities of the four classes of customers previously mentioned, viz. :—those for private lighting, motors, public lighting, and traction. The liability of an undertaking towards an individual customer, or towards a class of customer, depends on—

(1) The maximum demand—possible and probable.

(2) The time or times at which the maximum demand occurs.

(3) The duration of the maximum demand or of a demand nearly equal to the maximum.

(4) The degree of knowledge possible with reference to the variations of the demand with time; and

(5) The periods, if any, during which supply may be discontinued.

In the case of ordinary customers for lighting, experience has proved that the maximum demand, or greatest actual rate of supply, of almost every customer is considerably less than the demand possible with his installation; also that the maximum demands of all these customers are by no means simultaneous; the nett result being that the maximum load, or maximum demand, on the works is from 45 to 65 per cent. of the maximum possible load—thus, the actual liability, in respect to provision of plant (and, in a lesser degree, of mains, &c.) and in respect to capacity of running plant, is very much less than the apparent liability. Again, with regard to the predicated class of customers, experience has demonstrated that the time-load curves of one year are very similar, except, perhaps, in the first two or three years, to those of another, and that a time-table of actual liability can be drawn up with a fair amount of accuracy; such a time-table will show, of course, a relatively small liability except during a few hours daily, in which the liability will rapidly increase to a maximum (variable with time of year) and then more slowly diminish. Discontinuity of supply to private customers for lighting is usually possible without these suffering inconvenience in the hours of broad daylight, but is not possible during the hours of heavy load; hence work on mains is easily arranged for, but spare plant is necessary at the works and—on account of the period during which the load on the works exceeds 90 per cent. of its maximum value, lasting for some three hours in winter—the plant capacity cannot be taken at an overload rate.

Discussion.

In the discussion on Mr. Kilgour's paper, the engineers had by far the best of the argument. Mr. Faraday Proctor (Bristol) endorsed the views expressed in the paper, and said the matter was contained in the one phrase, "the cost of supply in general depends almost entirely upon the liabilities undertaken, and little on the actual supply given." Committeemen did not appreciate the difference between summer and winter losses, the latter being the heavier of the two, owing to day load losses being greater for the greater number of boilers and engines in use. After comparing some results in the paper with those obtained by Councillor Sinclair, he hoped Glasgow would have something to say, because their system could be summed up in a half-dozen pages. The maximum and minimum charges to different classes of consumers might with advantage have been given in the paper. Councillor Sinclair expressed approval of the paper, and

* As he believes many do still.

MR. C. E. C. SHAWFIELD (Wolverhampton) had his differences to bring forward. Stumbling over rates and taxes, whose allocation he had misunderstood, he denounced cast-iron tariffs, and urged an appeal to Parliament, to allow preferential trading. Customers could then be bargained with, and, after prices had been got down, the costs should be made to fit accordingly. COUNCILLOR IRWIN (Dublin) caused much merriment by his remarks on special charges to public-houses; and ALDERMAN BRODIE (Blackpool) stated the terrors of maximum demand, not only to customers, but also to committeemen, in November. MR. R. B. LEACH (Aston Manor) gave the trite advice of fixing tariffs according to load factor, and was at once followed by ALDERMAN ROBB (Tunbridge Wells), who deprecated science outside the works. Do as much conjuring with your costs as you like, but fix the price to the consumer, and let him settle the bill. Customers should not be made a party to the transaction of fixing the tariff, by installing indicating devices on their premises.

MR. J. F. C. SNELL (Sunderland), before beginning in earnest, had to correct an impression given to MR. BOOT the day previous, that he disagreed with the maximum demand principle. As to costs and tariffs, he adopted a policy in which present costs were compared with estimated costs of two years ahead, and an intermediate figure was taken between these limits, which enabled the customer to soon become profitable. All desired to make an equitable distribution of the costs over every class of consumer, so that it should be given as the opinion of the meeting that equity had nothing to do with it. ALDERMAN PEARSON (Bristol) wanted engineers and committees to jointly consult in the matter of tariffs, as each was equally concerned. A flat rate, with liberal discounts, prevailed in Bristol, but the maximum demand system required too much explanation to ever become popular. He approved of a fixed price, which, with the discount, a customer could understand. A passage of arms then ensued between COUNCILLOR KEMP, of Aberdeen, and MR. BRODIE, of Liverpool. The former, in announcing himself as "Kemp, of Aburrdeen," questioned the right of the man afraid of November to be where he was. A shout of laughter greeted the retort from Liverpool. "I am an alderman, that does not apply to me." But the Scotsman got home the next minute, calmly remarking that they had no such men in his country, but men they could handle, a rejoinder which met with hilarious approval. As chairman of both gas and electricity committees, he was above competition, but held the opinion that classes of consumers should be differentiated, and this could best be done by maximum demand systems. At this juncture MR. KILGOUR briefly replied, stating that his full remarks would be sent to the Proceedings. He, however, pressed home the inequitable methods of those who disagreed with him "that equity had nothing to do with it." He ascertained the cost of supplying a certain class, and if this amount was not realised, a loss resulted. But a certain sum, in addition, was also required, and this must be procured either from that class or all classes. His further remarks were reserved for the Proceedings.

THE SUPPLY OF ELECTRICITY IN INDUSTRIAL AREAS FROM A MUNICIPAL POINT OF VIEW.

By COUNCILLOR WILLIAM HODGSON
(Deputy Chairman of Salford Corporation Electricity Committee).

COUNCILLOR W. HODGSON.

THE near future will demand a supply of cheap electric power to be available whenever and wherever it is wanted, and whilst making no attempt at prophesying, the author is strongly of the opinion that the direct use of steam power will wane and become in a few years probably as "ancient" as water mills are now.

It is this new and unforeseen condition of things, coupled with increasing demand of recent years for electricity for all purposes, which puts additional responsibility upon the committee entrusted with the carrying out of the electricity "order" of municipalities.

Experience has already shown that even in so short a time most committees are finding themselves compelled by these changes which have been forced upon them to decide—if their undertaking is to be of a progressive nature and having regard to the size and capacity of plant already installed—whether a further extension on a comprehensive scale of such plant is desirable.

It is obvious that engineering, commercial, and financial policy enter into the question, and each in turn must have full consideration by committees when determining conclusively a sound future line of action upon which so much depends. The engineering, scientific, and technical section of the undertaking must act in harmony and sympathy with, and to a large extent be controlled by, enforced commercial and financial considerations, these two latter being often by their supreme importance placed in front of engineering achievements.

The electrical world seems to have entered upon a new and vigorous phase, opening up new possibilities and imposing new or altered conditions, and it is incumbent upon these responsible to realise and grasp intelligently the new state of things, and to lay themselves out for coping with this new but pronounced demand, by either adding to their present stations or making provision for others on the most economic "up-to-date" lines. They must perforce also seriously notice the fact that recent events are bringing into being large power companies in different parts of the country with practically unlimited capital, whose schemes involve the putting down of immense plant with the object

of supplying current for all purposes cheaply in manufacturing and residential districts. These power companies have in some cases commenced operations, and are offering prices for a combined lighting and power supply such as the municipalities have not even thought of. For instance, in the neighbourhood of Manchester contracts are being made by a power company at prices varying between ½d. and ¾d. per unit. There are also other projected companies now seeking Parliamentary powers to supply in areas already covered by "orders" granted to municipal authorities.

It must be borne in mind that in order to obtain consumers, the power companies have frequently to transmit their power several miles, involving heavy capital outlay on cables, and an appreciable maintenance charge. If the power companies can afford to supply at the low figure mentioned in spite of the distance over which the power has to be transmitted, surely the municipalities with the demand for energy at their very door can do so even better.

What, then, is the reason that municipalities have not yet been in a position to offer the low rates for power such as the power companies are now contracting for? The answers seems to be twofold:—(a) They have not realised the possibilities of power supply on a large scale, and are consequently not prepared for it. (b) They have hitherto hesitated to lay out the large sums of money required for adequately dealing with the problem.

With regard to the first reason, it is now evident that there is a demand for cheap electrical power, and that the demand can be met and consumers supplied at a reasonable profit from power stations designed on broad lines, but with strict regard to economy in both buildings and equipment. In the next place, with regard to the financial problem involved in a general power supply, the Legislature has placed upon corporations certain clearly defined responsibilities; in fact, in their areas they have, generally speaking, been given a monopoly of the supply of electrical energy. It is therefore the duty of municipalities to see that the privileges and advantages which the power companies are offering the country districts are available also for town areas; in other words, the municipalities, having been given a monopoly within their area of the public supply of electricity, are bound to undertake the supply of power on a sufficiently liberal scale to ensure the town manufacturers, often large ratepayers and employers of labour, the same facilities as will shortly be available in the country. Should they fail in their duty in this respect, they must not be surprised if the Legislature curtails the present monopoly and grants to power companies the rights to supply power to users in municipal areas.

It must not be overlooked that ratepayers requiring power have also rights and privileges which ought not to be set aside, and municipalities should learn that it is inexpedient to stand between such ratepayers and a cheap supply of electricity for power purpose, which would probably mean the increased development of the district. This fact ought to induce them to adopt a sound progressive policy, or give facilities to a power company to provide what they are either unwilling or unable to furnish, *i.e.*, electrical power at the lowest rates.

With plant rapidly approaching its full capacity electricity committees are now, therefore, faced with the question, and must answer it—Is new additional plant to be put down by them with a view to affording manufacturers a cheap supply of electrical power with a probable small margin of profit to the corporation? or, is the alternative to be adopted, viz.:—to maintain the present comparatively high price of current with its tendency to discourage large consumers and so render further extensions unnecessary, or in other words, contribute to their own extinction? The author has no doubt that the right decision of the committee would be, to answer the question in the affirmative and determine upon a progressive policy.

The trend of financial, expert, and progressive opinion is to make or produce electricity so cheaply that no one will be able to do without it. This may be a high and laudable ambition, but if that aspiration can only be realised we cannot tell what advantages it may bring to both industrial and residential areas. It is more than an aspiration, it is a probability, and its accomplishment would mean the providing of cheap power for trains as well as trams, it would operate docks and canals, it would dispense with the unsightly tall factory and works chimneys for ever belching forth dense black smoke, it would shut down the thousands of chimneys of dwelling houses through which the air-polluting domestic fires emit their poisonous atmosphere, and which are so largely responsible for the fogs experienced in our large cities and towns; in their place we should have cheap light, power, and heat, besides other apparent advantages, the description of which is outside the scope of this paper.

Discussion.

Here was a subject on which councillors could speak feelingly, and naturally they had most of the say in the discussion. ALDERMAN PEARSON (Bristol), who always gets a good hearing, knew a thing or two about power companies and bulk supply, as he was up against one in Bristol. As monopolists, they should not shirk their responsibilities, and, answering for Bristol, he said the reply of that city to the Somerset Power Bill was to vote £125,000 for plant to supply power. It was erroneous to credit power companies with unlimited capital. Of twenty-three undertakings only three were operating on the lines intended, and another three were doing a little. Their capital was very limited. A municipal body could borrow, not at 2½ or 3 per cent., but 3½ per cent., when the company could get no money at all. West Ham is never contented unless it makes its presence felt. ALDERMAN IVEY, of that illustrious borough, took the so-called monopolists to task because they were not really monopolists. The meeting protested, but Alderman Ivey would prove his case. At Finchley, a supply company had legally tested its right to run an overhead cable across a public thoroughfare, despite the protest of the local authority, and had won. Of course, the audience did not feel convinced. Alderman Ivey then scattered a few axioms on

municipal supply generally, among these being advice to extend the area and keep out the power companies. A near neighbour of West Ham, ALDERMAN BUSSEY (Poplar), had then to let off steam, but through the mists of his rhetoric he was understood to agree with his *confrère* just seated. ALDERMAN BRUCE (Sunderland) was more to the point in telling of what had been done in Sunderland to cope with the power demand. £75,000 had been spent, and very large contracts for power entered into. One firm agreed to take supply for five years, at $1\frac{1}{8}$d. per unit. This figure elicited the cry of "terribly dear" from some member present. JUDGE MCPHERSON upbraided Alderman Ivey for quoting Finchley, and inveighed against a Parliament which encourages company trading. MR. PROCTOR (Bristol) believed that $\frac{13}{16}$d. per unit was a profitable figure from his experience with it in Bristol, and MR. SHAW (Ilford) thought the power companies had an advantage in being able to supply motors. MR. SNELL (Sunderland) had evidently been pinked by the voice crying "terribly dear" on his $1\frac{1}{8}$d., for he replied vehemently that when manufacturers could not supply at less from their own plants, the municipality should get the best price it could. The reply of COUNCILLOR HODGSON, which was brief and to the point, brought the discussion to a close.

EXTENSIONS TO OUTLYING AREAS.

By A. B. MOUNTAIN (Chief Electrical Engineer, Huddersfield).

A. B. MOUNTAIN.

In the author's opinion, this subject requires consideration from two distinct points of view:

1. The policy of extending the area of supply into districts governed by other authorities.

2. The engineering problems connected with such extensions.

Many corporations are supplying water and gas, and a few are supplying electricity to the adjacent areas, and in practically every case are charging from 10 per cent. to 25 per cent. more outside the boundary of their own area. We find in some cases two towns actually side by side, managed separately with duplicate undertakings, which could by combination even now effect very considerable economies. By deferring amalgamation enormous sums of money have been practically wasted upon the duplication of sewerage, water, gas, tramways, electrical, and many other works or departments, which could be more economically and successfully managed by one central authority controlling a large area. The argument of the outer areas is nearly always based upon the fact that rates are lower in their area than in the central one, but this is only because their responsibilities are less; and the advantage in the rates is often more than counterbalanced by the increased charge for water, gas, and electricity.

It would seem to the author to be the actual duty of all the large central authorities to extend the electric supply mains into those districts immediately surrounding the central area, if it is considered probable that future extensions of their boundaries will bring these districts under the control of the central authority. If this will not be the case the matter becomes a question of municipal trading, and it must be considered upon purely business lines. The price to be charged for the energy supplied to the districts outside the control of the central authority involves several complicated points: the districts bear no risk of contributing to any losses upon the undertaking, nor do they receive any profit, but they contribute towards the repayment of capital or purchase of the works, which eventually belong to the central authority, so that the charge might be uniform throughout the whole area, if it were not for the fact that the cost of supplying such outer districts, owing to the increased capital outlay per consumer, is more than for the central position of the area. In most cases an additional charge of 10 per cent. would be ample protection, and the cost of supplying electricity in the case of a small village installation is so low that it is doubtful if more than this could be obtained. If it be considered desirable to supply the outlying areas, a commencement should be made as soon as possible, because the neighbouring power company will certainly endeavour to supply these areas; and should they succeed, and the area afterwards become amalgamated, it will no doubt be a costly operation to buy out the company.

Assuming that there are outlying districts within five miles of the centre of the town, and that such districts have a scattered residential population, with the houses on the sides of the main roads, or in the form of small villages, it is obvious that the cost of mains per consumer will be very much heavier than in the central portion of the area, and it is also a fact that the revenue or units sold per lamp is less; consequently it would not be profitable to undertake the supply upon the same lines adopted in the town unless such supply was a high pressure one. But as most towns are now generating high pressure alternating currents, the cost of mains may be by the use of such high pressure considerably reduced, and it is comparatively easy and economical to deal with extensions within the limits suggested.

If the outer districts to be supplied are of a residential character, the most suitable and economical arrangement would be to carry the high pressure alternating current either 1, 2 or 3 phase by underground mains to the approximate centre of each village, reducing the pressure by static transformers and distributing by overhead wires.

The cost of connecting consumers is considerable if the distribution is by means of underground mains and service. The average cost of connecting consumers by underground low pressure service is about £7. With overhead wiring

for distribution, this average cost is reduced to about £4, in both cases meters and fuses being included.

The cost of overhead mains in a system where conductors of small sectional area are to be used may be put at about half the cost of underground mains, the heavier the main the less being the advantage of placing the same overhead. There are other advantages with an overhead distributing system which make it particularly suitable for outlying areas.

At present, however, the feeling against overhead mains seems so strong that it is only possible to obtain consent for their erection in the more enlightened areas.

In some cases the District Council may prefer to purchase in bulk and distribute themselves. From the consumer's point of view there is little to be said in favour of this arrangement; it must increase the charge, due to the extra engineering and clerical supervision; it will cost the central authority very little more to keep in order fifty extra meters, take readings from the same, and render and collect the accounts, whereas the District Council would require to engage someone to do this work and generally supervise the distributing system, which would cost from 10s. to £1 per consumer. This useless addition to the cost will make it very difficult in small places to obtain consumers.

There are several advantages in supplying the surrounding areas. The load factor is improved, due to the following facts:

The market day in the town is usually the village half-holiday.

Fogs, thunder-storms and dark clouds seldom cover the whole area at the same time.

The demand being mainly for residence lighting, the load upon the works will be prolonged until late in the evening.

The street lighting which may be obtained is of considerable assistance to the revenue and the load factor, and if overhead wiring is adopted the lamps may be fixed most economically upon the poles and a switch wire run back to a central position, so that all street lamps may be switched on or off from one point without the expense of lamp lighters.

The enlargement of the demand reduces the proportion of the standing charges per unit sold throughout the whole area.

To give some idea of the comparative cost of supplying from a small village installation and by means of mains extended from a central area, and to emphasise the importance of keeping down the capital expenditure, particulars are given of an existing installation just completed by the author, and the estimated cost of supplying from a central source by underground and overhead distributors.

The population within the area is approximately 4,000, the estimated number of lamps which will be connected at the end of the second year, 2,800 of 8c.p.; the revenue, based upon the present consumption, will be as follows:—

16,760 units sold to private consumers, at 4¾d. per unit......	£330	1	8
3,240 units per 40 street lamps...	40	0	0
Meter rents.........................	20	0	0
	£390	1	8

Central Expenditure, District Council's Installation.

Cost of generating works having a capacity of 68 kilowatts. Gas engines, dynamos, and switchboard	£1,400	0	0
Overhead wiring 5¼ miles, services and meters for 80 consumers, 40 street lamps.........	1,600	0	0
	£3,000	0	0

Central Supply with Overhead Distributors.

Proportion of cost of generating works, 68 kilowatts, at £20	£1,360	0	0
4 miles of 2,000 volt feeder cables with a capacity of 100 kilowatts	1,230	0	0
Substation and transformers...	110	0	0
5¼ miles of overhead wiring...... 80 services and meters............ 40 street lamps.......................	1,600	0	0
	£4,300	0	0

Central Supply with Underground Distributors.

Proportion of cost of generating works...........................	£1,360	0	0
4 miles of feeder cables...........	1,230	0	0
Substation and transformers...	110	0	0
5¼ miles distributing cable.......	1,950	0	0
80 service and 40 street lamps...	700	0	0
	£5,350	0	0

The cost of Supply, District Council's Installation.

	pence per unit.
Total cost for 20,000 units, excluding capital charges................	2.25
Interest and sinking fund charges, 6 per cent. upon £3,000............	2.16
	4.41 — £376 10 0

Supply from Central Area with Overhead Distributors.

Total cost for 20,000 units sold in the outer area, excluding capital charges	1.00
Interest and sinking fund charges, 6 per cent. upon £4,300............	3.09
	4.09 — £340 10 8

Supply from Central Area with Underground Distributors.

Total cost for 20,000 units sold in the outer area, excluding capital charges	1.00
Interest and sinking fund charges, 6 per cent. upon £5,350............	3.85
	4.85 — £404 3 4

From the above statement it will be seen that by adopting overhead wiring a difference of ⅓d. per unit could be made in the charge, which, as

already pointed out, is of the greatest importance when dealing with small consumers. The comparisons are, of course, only true during the first few years. As the feeders become loaded the capital charges per unit are reduced; the proportion of the capital allowed for the generating works is also reduced, due to the improvement in the load factor.

Discussion.

Mr. S. L. Pearce (Manchester) was the best man possible to open the discussion, as his experience of outlying districts is about unique in this country. Talk of incorporation as the result of electricity supply should give place to engineering considerations of the problem, when the inexpediency of extensions would be evident. In his own case, four areas, though incorporated, could not be supplied because of the high capital cost. Overhead wires reduced the outlay, but there were difficulties in getting Board of Trade consent. In the matter of load factor he found that additional outlying areas reduced the load factor. Mr. R. A. Chattock (Birmingham) looked at the matter from the worker's point of view, and their dwellings should be included even beyond five miles. An extra 10 per cent. charge was quite out of the question, and would, he thought, be vetoed by the Board of Trade. Councillor McGaul (Birkenhead) believed in a higher price, and his committee got it without protest from the Board of Trade. Mr. J. C. Griffin (Swindon), who whispered to the President instead of addressing the meeting, despite all attempts to "turn him round," had something to say on boosting feeders to outlying districts. He had found it possible to increase the capacity of a feeder, left too small by a shortsighted predecessor, without laying another main. Mr. J. K. Brydges (Eastbourne) made assurance doubly sure by obtaining a guarantee of a minimum consumption from residents in the outer area before extending the mains. He also got a higher price under the eye of the Board of Trade. Alderman Hey (Halifax) quoted the bumptiousness of his outer neighbours, who, with a small destructor, or even a private plant, offered him current at attractive rates. Local patriotism had to be reckoned with in these cases, and electricity supply showed the cloven hoof of amalgamation. Mr. A. E. Hadley (the Electrical Co.), about the only manufacturer to say a word or two, approved of overhead wires, because they were used abroad with success, and also because Parliament now seemed to favour their use. Alderman Pearson (Bristol) emphasised the antagonism of Parliament to these extensions of municipal areas as the great stumbling block. In Bristol a certain area might not be crossed with mains to reach another district beyond it because that area might ask for a supply. He should certainly dissent from supplying the outer districts at the same price, though there was no profit for a year or two in any case. Local feeling was frequently strong against incurring obligations to the central authority, as incorporation was regarded as undesirable. After Mr. A. G. Cooper (Colne) had cited his experience with the Yorkshire Power Co., the audience was almost deafened by the stentorian tones of Councillor Chatterton (Huddersfield), who laid down the law with emphatic tone, but none too apt phrase. Business had nothing to do with it; human nature lay at the root of the matter—a truism not lost on the audience. His own district and his own engineer came in for some criticism, and, in fact, the worthy councillor was quite carried away with his own eloquence. Engineers' "perquisites" were once mentioned, but evidently this was meant for something else. With the remark that he could "go on," the speaker seated himself at last. Mr. A. B. Mountain, replying, thought that point of view counted for something, because Messrs. Pearce and Chattock had different districts from his. Speakers on overhead wires were to understand that he had actually erected them, and with Board of Trade approval and that of the district. Load factor was certainly improved in his case, but this was due to the half-holidays in the different suburbs.

ELECTRICITY SUPPLY BY FREE WIRING AND PREPAYMENT METERS.

By ALFRED R. SILLAR
(Chief Electrical Engineer, Colchester).

A. R. Sillar.

The object in bringing this paper before the Association is to give a few hints to those station engineers who have never seriously considered the introduction of free wiring and the supply of current by means of prepayment meters into their towns.

The supply of electricity by free wiring and slot meters is one which affects the residences of the lower middle and working classes almost entirely, together with a large number of small shops, the tenants of which live from hand to mouth, and cannot afford to spend money on an installation. These small consumers can be brought to be a very useful source of supply, and at the same time they will be found to be a first-class method of advertising the light, and the author is prepared to prove that since the introduction of free wiring he has received a number of applications for current on the ordinary system which he would not have had, had it not been that the consumer was recommended by a working man who had already got a supply in his cottage.

The man who wants electricity in his house is the better class artisan and shop assistant who is accustomed to have it at his work and knows the benefit of it, and at the same time the author finds that a large number of labourers, warehousemen, &c., earning not more than £1 a week avail themselves of a supply.

With regard to canvassing, the author's method of procedure has always been as follows:

While the cable is being laid in the road two circular letters are forwarded to each house. The first one explains that a supply will be available immediately, and sets forth at length the advantages of electric lighting over other methods of illumination.

The second circular is given verbatim, as it may be useful to engineers who have not yet adopted this system:

"I am directed by the electric light and power committee to inform you that they have established a system of electricity supply in the borough by means of free installation in conjunction with penny or shilling in the slot meters at the option of the consumer.

"In the case of business premises the corporation will supply any number of sixteen candle power or eight candle power lights fitted to pendants or brackets, together with the necessary wiring, switches, &c., providing that the consumer can show that these lights will be in use a reasonable number of hours during the year.

"In the case of residential premises four lights would be installed as above in the following positions:

Hall ..	1	8 c.p.	pendant or bracket,	1 switch.
Front room	1	16	,, ,,	1 ,,
Back room	1	16	,, ,,	1 ,,
Kitchen ..	1	8	,, ,,	1 ,,

"Any reasonable alteration to the positions of the above lights will be considered by the borough electrical engineer, and any further lights will be supplied and fixed by the corporation upon the payment of 8s. each.

"The cost of current supplied to the consumer under this system would be as follows:

For a 16c.p. lamp about 3 hours one penny.
For an 8c.p. lamp about 5½ hours one penny.

"In order to keep consumers' lamps in as good a condition as possible a new lamp will be given upon application at these offices after the consumption of each 40 units registered on the meter.

"In all cases premises will be connected to the corporation's mains free of charge.

"My representative will call upon you in a few days' time and will give you any further information you may require."

These two circulars are enclosed in an envelope and addressed "Important" with a slip stating that a representative will call upon a certain day, and they are followed up with an evening visit by one of the members of the staff, usually the chief clerk, who is in a position to explain any details which the would-be consumer might not understand.

The representative also takes with him some copies of the agreement, and anyone deciding to take a supply fills up this form and has it witnessed. This agreement has been purposely kept as simple as possible, so as not to frighten intending consumers, and is made between the town clerk as acting for the corporation, the consumer, and the landlord. The use of the agreement is to keep the installation in the hands of the council, to insure access to the installation at all reasonable times, and to prevent the consumer or landlord from interfering with it. The consumer or the landlord may purchase the installation any time on payment of the full value, and the corporation reserves to itself the right of removing it at any time when it might be considered necessary.

The corporation do not undertake any work in connection with free wiring, but a specification is issued for fifty installations at a time and given out to a local contractor. In the cottage or dwelling four lights are supplied:—the one in the hall being merely an encouragement for obtaining consumers, as the revenue from it is practically nil, and the other three, those in the front room, back room, and kitchen, always pay their way. Consumers are also given the option of having the hall light fixed in a bedroom as a further inducement; the gas company only allowing three lights and making an extra charge for anything further. The present cost of these installations, taking fifty at a time, is 35s. per house exclusive of the lamps, which are supplied direct from the department, and the total cost of a house wired as far as the meter is therefore about 39s. In laying the service main, where the applications are sufficiently numerous, the cable is looped from one cottage into the next, in some cases three or four being connected in this manner. The average length of twin 3/20 vulcanised cable per house is 12 yards, and this, with the cost of the joint-box, house terminal box, meter board, meter, and the men's time laying and fixing, averages over the whole of the installations, £4 19s. 3d.

The greatest item of cost attached to free wiring is that of the prepayment meter, and although there are meters on the market at a fairly cheap price, the author has found by experience that it pays in the long run to get a meter which will be as nearly reliable as possible, even if the cost of it is considerably higher than the average. At the present time he is using three different types of meters, two of the mercury motor, and one of the shunt motor type. Of these meters he considers that the mercury is the better, as the great trouble of the motor stopping through a dirty commutator is avoided.

The author has tried a good many different types of lamps on the slot system, and amongst others some very high efficiency ones, which gave nearly 25 per cent. more light for the money, but owing to the complaints of blackening, he has gone back to a first-class four watt lamp, and finds that it cannot be improved upon with this type of supply.

The price for current charged up to the present has been 6d. per Board of Trade unit, as compared with 5d. less 5 per cent. for cash received from ordinary consumers, and the difference allows a sum of 1d. per unit for the repayment of the installations. Since April 1st, however, the price to ordinary consumers has been reduced to 4½d., and the slot meters are being changed by means of replacing the change wheel to supply current at 5½d. per unit. As the slot consumer pays cash for his supply, the author always considered him entitled to the 5 per cent. benefit given to the ordinary consumers, and he has lately introduced a plan whereby any slot consumer, having used over 40 Board of Trade units, can obtain a new lamp by calling at the offices, where the claim is verified by reference to the meter register. The supply of these lamps

serves a double purpose, as not only does it assist the consumer to replace his lights without any cost to himself, but it also keeps up the consumption of electricity, and the revenue from these installations.

We now come to the principal question to be dealt with in this paper:—that is as to whether an installation on the slot system is a paying concern or not. Some figures are given in relation to these installations which have been taken from the books of the department. The number of consumers dealt with are those which have been running throughout a complete financial year.

TABLE A.

Number of consumers, 82.

Units supplied, 7.433.

Units sold per consumer per annum, 90.6.

Amount received per consumer per annum, £2 5s. 4d.

Average cost of installation complete with lamps, £2 8s. 1d.

Average cost of meter, terminal box, and service cable fixed, £4 19s. 3d.

Average cost of meter, &c., per equivalent 8 c.p. lamp, 12s. 3d.

Average cost of meter, terminal box, service cable, &c., to the ordinary consumer per equivalent 8c.p. lamp, 1s. 11d.

Number of lamps actually connected, 422.

Number of equivalent 8c.p. lamps, 665.

Number of lamps connected per consumer, 5.14.

Number of equivalent 8c.p. lamps connected per consumer 8.11.

In the second table is shown the financial result per installation, at Colchester. As the cost of the installation is to be written off in five yearly instalments of 20 per cent. each, this amount will, of course, very largely reduce the profits on this system of supply, although it must be borne in mind that when the cost of the installation is paid off, an additional profit of about 10s. per consumer will be realised. Some towns have obtained a special grant from the Local Government Board, allowing them to borrow money for the installation costs of free wiring, but the author has managed to pay for his system by means of an overdraft at the bank.

TABLE B.

	£	s.	d.
Revenue.			
90.6 units at 6d. per unit	£2	5	4
Expenditure.			
Cost of generation and distribution 90.6 units at 1.7d.	0	12	10
Standing charges on 90.6 units at 1d. per unit	0	7	6
Repayment of installation at the rate of 20 per cent. on £2 8s. 1d.	0	9	7
Additional interest and sinking fund on slot meters and service mains at 6½ per cent. on £4 4s. 6d.	0	5	6
Cost of lamp renewals at 4 per cent. of the revenue	0	1	9
Net profit per installation	0	8	2
Total	£2	5	4

After five years have elapsed and the cost of the installation is paid off, the nett profit, taking the above figures standing as they are at present, will rise to 17s. 9d. per installation.

Discussion.

MR. R. B. LEACH (Aston Manor) opened fire on Mr. Sillar, reading from voluminous notes. The lamp chiefly used in small houses was in the kitchen, and £2 5s. 4d. per consumer seemed too much revenue for this. The installation cost seemed too low, and slot meters could not be depended on, and, finally, until supply was cheaper and lamps improved, customers of this class should not be entertained. MR. A. H. SHAW (Ilford) had not met with such good results as Mr. Sillar. Installation cost was £3 13s. 6d., and the receipts only averaged £1 5s. 10d. Connecting up cost £5 2s. 10d., but he now arranged with builders to run a cable through the entire block, and tappings were taken to each house. Mercury motor meters were not sensitive enough, and ordinary motor meters had shunt losses. MR. E. T. WIILLIAMS (Gibraltar), who easily made himself heard, recounted some interesting experiences at Gibraltar. A charge per lamp was made, and the expense of meters was eliminated, this proving quite satisfactory. In Spain the rental system was much in vogue in districts supplied with hydro-electricity. His hire-purchase system worked out at 1½d. per lamp per month (up to 16cp.), and 1d. per lamp in clusters, and arrangements had recently been made for supplying up to 10.8c.p, at 1d. per lamp. MR. J. G. GRIFFIN got a surety on a three-year hire-purchase system from his customers, and MR. H. R. BURNETT (Barrow) gave his own encouraging experience with 1,000 workmen's dwellings, in which the landlord not only supplied, but looked after the meters. MR. C. TURNBULL (Tynemouth) feared the price would get below that to the ordinary consumer, and MR. C. H. CORRINGHAM (Leeds) referred to an experience in Stamford, where meters were not used, which had ended in failure. MESSRS. VIGNOLES and BUTTERWORTH foresaw difficulties, and MR. H. BOOT (Tunbridge Wells) could say no good word for the prepayment meter. The discussion was closed by remarks from MESSRS HEY, BRYDGES, and CRAMB. MR. SILLAR maintained all he had said in the paper, and, in reply, explained his high revenue per consumer and low installation costs as due to small shops and competition among contractors. The B.T.-H. prepayment meter was used by him with complete success.

At The North British.

(AN ACTUAL EXPERIENCE.)

Our Acting Editor: Waiter!

Waiter: Sare.

O. A. E.: I left a packet of letters on the break-fast table this morning. What became of them?

Waiter: I see, sare.

(Three hours later.)

O. A. E. (at lunch) Waiter, where is that packet of letters?

Waiter: I see, sare.

(Consults head waiter; both dive behind screen.)

Waiter (entering with undistinguishable mass of paper, photos, grease, beetles, potato peelings, &c.): Your lettaires, sare!

O. A. E.: ? ? ? —— ? ! ! ! —— ! ! !

(Exit waiters, hurriedly leaving *O. A. E.* with wreckage.)

ANNUAL DINNER.

Thursday evening, June 30th, had been fixed for the Annual Dinner, and the function had the president for its chairman, with admirable supporters in the shape of Sir Joseph Cranston, the Lord Provost of Edinburgh, and Bailie Willock, of Glasgow Electricity Committee. No great enthusiasm was displayed, but the flashes of wit and zeal of the men from Edinburgh, Glasgow, and Aberdeen, to do each other down on points of local pride and honour, were all much appreciated. But Scotch was everywhere, in many cases undiluted, and even the skirl of the bagpipes was inflicted on, we fear, unappreciative ears. The " man behind the skin " was more admired than the weird sounds he produced. With the singing of " Auld Lang Syne " the company broke up.

ANNUAL MEETING.

On Friday, July 2nd, the annual general meeting was held, and business for the ensuing year settled.

The following is the list of the new council:

President.

Mr. J. E. Edgcome (Kingston-on-Thames).

Vice-Presidents.

Mr. C. D. Taite (Salford),

Mr. S. E. Fedden (Sheffield).

Council.

Councillor Sinclair (Swansea).
Ald. Smith (Barrow-in-Furness).
Ald. Bruce (Sunderland).
Ald. Robb (Tunbridge Wells).
Bailie Willock (Glasgow).
W. W. Lackie (Glasgow).
R. A. Chattock (Birmingham).
A. A. Day (Bolton).
J. K. Brydges (Eastbourne).
J. Christie (Brighton).
Hamilton Kilgour (Cheltenham).
H. Talbot (Nottingham).
S. L. Pearce (Manchester).
C. E. C. Shawfield (Wolverhampton).
C. Wilkinson (Harrogate).

Hon. Solicitor, Ald. G. Pearson (Bristol).

Hon. Treasurer, Mr. J. H. Rider.

Hon. Sec., Mr. H. Faraday Proctor (Bristol).

The reading of the annual report followed, from which we take a few extracts. Some important amendments were made in the new Board of Trade regulations at the suggestion of the Association, and a set of conditions of supply has been completed, and will be embodied in the Proceedings. The testing and certification of carbon filament lamps has been taken with considerable energy, and the matter is now being conjointly considered with the Physical Standards Sub-Committee of the Engineering Standards Committee. For this reason the report will not be issued until later. ALDERMAN SMITH (Barrow) proposed a resolution regarding the reduced period for the repayment of loans, which was seconded by MR. SNELL. The resolution, which read as below, was carried after some discussion: " That this meeting views with serious apprehension the recent action of the Local Government Board in reducing the already short period allowed for the repayment of loans for electricity undertakings, and believes that such alteration is not only unnecessary, but threatens seriously to handicap legitimate municipal electrical enterprise. It therefore enters its protest against the very short period now being allowed, and hereby empowers the council to take such steps as they may deem necessary to bring about a more equitable and more uniform treatment."

The report and balance sheet were then both unanimously adopted.

EXTERIOR McDONALD ROAD STATION, EDINBURGH.

INDEPENDENT CONDENSING PLANTS.

The Mirrlees, Watson Co., Ltd., Glasgow.

OWING to the very great interest being taken at the present time in the adoption of independent condensing plants as a means of securing greater economy in the working of electric power stations, we have much pleasure in placing under the notice of our readers a few particulars of several plants of this type which have been recently installed in the Glasgow district, and which were open for the inspection of the members of the Incorporated Municipal Electrical Association attending the recent convention, when on their visit to Glasgow.

Perhaps the finest show as regards condensing plant arrangement was that at the Pinkston tramway power station, whence all the cars throughout the magnificent Glasgow tramway system are operated. This station lends itself well to making a good show, as there is ample light and plenty of room to get about. The condensing plant, we noticed, as well as the boiler feed pumps, were supplied by the well-known firm, the Mirrlees, Watson Co., Ltd., of Glasgow.

We give below a few of the main particulars of this plant which will no doubt be interesting. There are four main condensing sets, the condensers having heavily ribbed cast-iron bodies. Each of the condensers has a cooling surface of 7,000sq. ft. and is designed to deal with 60,000lb. of steam per hour. The air pumps are of the three-throw Edwards type 16in. diameter by 12in. stroke, running at 150 revolutions per minute driven by a slow-speed motor connected direct to the pump crank-shaft.

There is also an auxiliary surface condensing set, built on the same lines as those of the four main sets but of a capacity suitable for condensing 24,000lb. of steam per hour, the condenser having 2,800sq. ft. of cooling surface. The air pumps in connection with same are also of the three-throw Edwards type, 11in. diameter by 10in. stroke, running at 150 revolutions per minute. For boiler feeding there are four sets of three-throw plunger type pumps, each having a capacity of 8,000 gallons per hour when running at 45 revolutions per minute; each pump is driven by an electric motor through double reduction spur gear. The general arrangement of this station has so often been illustrated that it must be familiar to most of our readers.

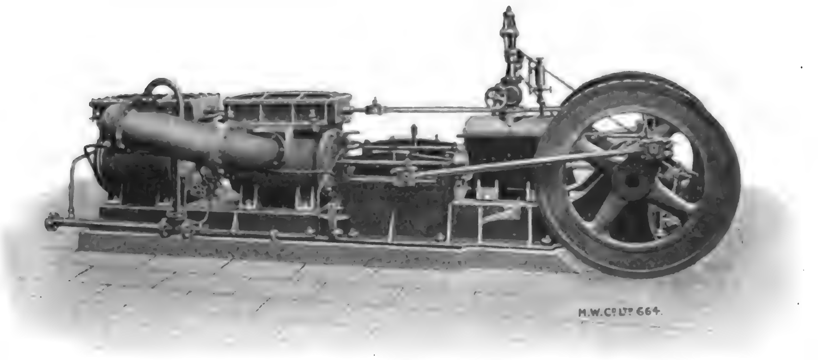


FIG. 1. CONDENSING PLANT AT YOKER POWER STATION. CLYDE VALLEY POWER CO.

Another important power station is that of the Clyde Valley Electric Power Supply Co. at Yoker, which was visited by some of the Convention members. The steam to be condensed in this case is from 1,500kw. Westinghouse turbines, with which it is imperative that the highest possible vacuum be maintained. The air pumps here are of the "Dry Air" type, and are constructed on the "two stage" principle, both cylinders being fitted with mechanically controlled slide valves. They also have equalising ports, by which connection is made between the two ends of the cylinders when the piston reaches

the end of each stroke, thus neutralising the bad effect of clearance, for, at the commencement of each suction stroke, instead of the clearance space being filled with air at the discharge pressure, it is at a pressure slightly above that of the condenser. These pumps, as illustrated in Fig. 1, are of the Mirrlees, Watson Co.'s latest design for the dry air system of working. The condensers are of the vertical surface type, carefully arranged to give counter-current action. The air is extracted from them by the aforementioned pumps, whilst the water is extracted by submerged centrifugal pumps driven by electric motors so connected that they are brought to a convenient position for inspection. The condensers each have 6,250sq. ft. of cooling surface. The cooling water passes three times through the full length of the condenser, and in counter direction to that of the steam.

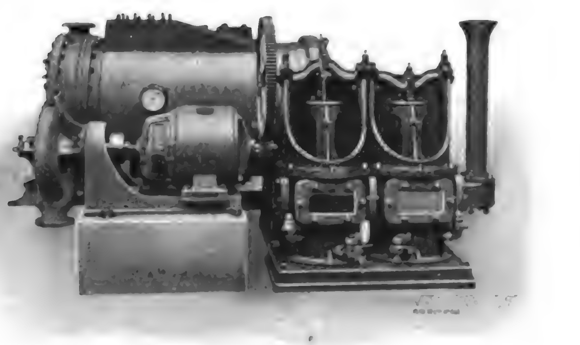


FIG. 2. THE MIRRLEES, WATSON CONDENSING PLANT. PARTICK CORPORATION.

The horizontal air pump, already described, is very compact in design. The crosshead, coming between the steam and air cylinders, prevents the air pump rod from entering the steam cylinder or becoming heated by it, thus avoiding difficulties with the packing glands.

Another type of condensing plant has been adopted very successfully by the Scottish Co-operative Wholesale Society at Shieldhall, also designed and constructed by the Mirrlees, Watson Company. This plant is of the barometric or elevated jet condenser type, working in connection with an open type cooling tower, which, to suit local conditions, rests on the boiler-house roof, and the condenser draws its injection water from the collecting tank at bottom of the cooling tower. This plant is capable of dealing with 48,000lb. of exhaust steam per hour from three sets of engines, two of 300kw. and one of 250kw. capacity, all of the enclosed high-speed type, and is designed to give a 26in. vacuum at this load.

The elevated condenser is of the "Mirrlees Improved" counter-current type, fitted with a series of specially formed trays for distributing the water in the form of thin sheets or cascades as it falls down to the bottom of the condenser, meeting the uprising vapour on its way to the pumps.

The air pumps are vertical, of the dry slide valve type, single stage compression. Two cylinders, 16in. × 15in., are mounted tandem fashion above the cross-compound steam cylinder, and the air valves are arranged with the equalising ports already described in connection with the Yoker pumps.

The circulating pumps are of the vertical double-acting flywheel type, the pumps being 18in. diameter by 12in. stroke, running at 80 revolutions per minute. They are driven by a direct-acting cross-compound engine having steam cylinders 13in. by 22in. diameter by 12in. stroke.

At the Partick Corporation lighting station there is a very compact condensing plant, also designed and constructed by the Mirrlees, Watson Company. This plant, illustrated in Fig. 2, is of the surface condensing type, with the Edwards type of air pumps and centrifugal circulating pump; the latter is bolted direct to inlet water branch of condenser. The pumps are driven by a single motor; and this method of driving has its advantages, as will be shown later on. The plant takes the steam from several high-speed engines, aggregating 18,000lbs. of steam per hour, and is designed to give a 26in. vacuum at the engines with cooling water from a natural draught cooling tower supplied along with the condensing plant, the main dimensions of which are as follows:—

Surface condenser, 2,300sq. ft. cooling surface.

Air pump, two throw type, 15in. diameter by 8in. stroke, at 155 revolutions per minute.

Centrifugal circulating pump to lift 1,275 gallons per minute.

In cases where the water head, against which the centrifugal pump has to work, is fairly constant, and independent speed regulation of the pump is not required, then the arrangement having the air and circulating pumps driven by a single motor, has advantages over that in which each pump is driven by its own motor. With air pumps the power required is greatest at starting—quite twice that required while at work under normal conditions—so it is advantageous to have an extra large motor to meet the increased demand at starting. On the other hand, with the centrifugal pump the power required is low at starting and increases as the pump gets to speed. These conditions are nearly counterbalanced by adopting a motor common to both pumps; in fact, the starting load for a combination is frequently less than a normal working load, thus facilitating starting, and removing the troubles which might arise from excessive overloading.

Another local installation of condensing plant is that supplied by the Mirrlees, Watson Co. for the Govan Corporation electricity works and similar in design to that at Partick station, but in this case there are three sets of surface condensing plants working with a chimney type water cooler. Two of the plants are designed for condensing 13,000lb. of steam per hour from several small units. The other is designed for condensing 18,000lb. of exhaust steam per hour from a high speed engine.

The steam to each plant passes through an oil separator, and has a by-pass through an automatic relief valve to the main atmospheric pipe. The surface condensers for the 13,000lb. plants have each 1,300sq. ft. of cooling surface; two-throw Edwards air pumps, 12in. diameter by 6in. stroke, running 172 revolutions per minute, centrifugal circulating pump discharges 760 gallons per minute. The surface condenser for the 18,000lb. plant has a cooling surface of 1,800sq. ft., two-throw Edwards air pumps, 13in. diameter by 8in. stroke, running 150 revolutions per minute: centrifugal circulating pump discharges 1,050 gallons per minute. In each case there is one motor directly connected to the centrifugal pump by a flange coupling. The other end of the motor spindle is fitted with a raw hide pinion for driving the air pumps by single reduction gear.

Another design of condensing plant is the "parallel flow jet condensing" type, which has been adopted by the Kilmarnock Corporation for the tramway station. This plant, illustrated in Fig. 3, is designed for dealing with 18,000lb. of exhaust steam from high-speed engines. The condenser is of the peg top form, and is fitted with spraying nozzle, which is regulated by handwheel and gear from the front of the plant.

The Mirrlees, Watson Co. make it a special feature in this type of pump to have the frames open in front and supported with stiffening columns to allow the pump bucket, delivery plate, &c., being readily withdrawn without disturbing the crankshaft. The steam cylinders are arranged for working compound. A small boiler feed pump is shown attached to the air pump bedplate and driven from the main crankshaft, the whole arrangement being very complete and accessible.

At the Glasgow Corporation's St. Andrew's Cross station, considerable interest was taken in the new Willans-Siemens turbo-generator, the exhaust steam from which is dealt with by a surface condenser and a

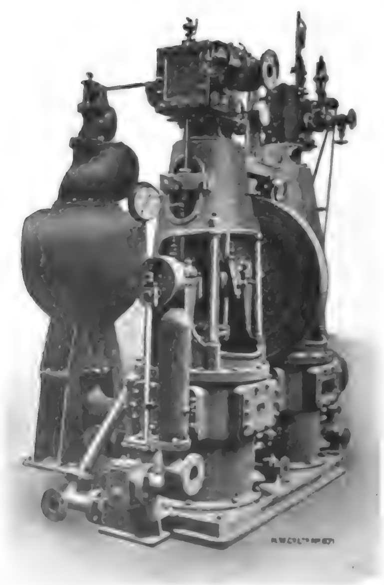


Fig. 3. Condensing Plant Kilmarnock Electric Tramways

Mirrlees, Watson three-throw air pump driven electrically.

The Mirrlees, Watson Co.'s works not being far from the above station, many members of the convention took the opportunity to visit them. These extensive works are situated on the south bank of the River Clyde, convenient to rail and principal shipping docks, are substantially built, well equipped with modern tools, compact and well lighted. In Fig. 4 is a part view of one of the erecting shops. The working floor area of the various shops is about six acres, and there are on an average something like 1,000 hands employed. This firm has been long famed for the manufacture of sugar machinery, which has been sent to all parts of the sugar-producing world, and in connection with same have had long and varied experience in the manufacture of independent condensing plants for use with the evaporators and vacuum pans so extensively used in the sugar industry.

Whilst passing through the works, the following condensing plants in course of construction attracted considerable attention:

A sub-base surface condenser for a 1,500kw. Curtis turbine. This condenser forms the base of the turbine and thereby saves the whole floor space, which would otherwise be occupied by an independent condenser. The exhaust steam discharges direct into condenser, thus eliminating exhaust pipes.

A three-throw set of Edwards air pumps for same.

An elevated jet condenser, with a pair of vertical dry air pumps, 16in. diameter by 15in. stroke, motor driven, to work in conjunction with a Rateau turbine, for the Steel Co. of Scotland.

FIG. 4. VIEW IN ONE OF THE MAIN BAYS OF SCOTLAND STREET WORKS OF THE MIRRLEES, WATSON CO., LTD.

Another similar though smaller pair of vertical dry air pumps, also motor driven, were running under test.

There were also noticed various parts of a dozen or more sets of condensing plant in different stages towards completion here and there throughout the different departments.

CALCUTTA ELECTRIC SUPPLY CORPORATION.

In this number we have dealt with the supply of electricity for lighting and power purposes by English municipal authorities. By way of contrast an account of what is being done by a private company to meet the demand for electricity in India may be of interest to our readers. We therefore select the largest Indian electric lighting station, and give below a brief description of the Calcutta Supply Corporation, the past history of which has been so successful both from the engineering and financial points of view.

The original concession for the supply of electricity for lighting and power purposes was granted in 1896 to Messrs. Kilburn and Company as agents of Messrs. Crompton and Co., Ltd., and was gazetted in January, 1897. As soon as the concession was granted the Calcutta Electric Supply Corporation was formed and an agreement made with Messrs. Crompton and Company for the supply, erection, and fixing of the buildings, plant, machinery, and cables for the first station. At the commencement there was some difficulty in obtaining a suitable site for the generating station, and the use of overhead wires caused some little delay, but at the first meeting of the shareholders in 1898 the chairman was able to report that considerable progress had been made.

The supply of electricity commenced on April 17th, 1899, and on December 31st in that year an equivalent of 9,463 lamps of 8c.p. were connected to the mains. On that date, after nine months' work only, there was a nett profit of £651 15s. 9d.; in other words, the company paid from its commencement, and has never looked back. In 1900 a licence was procured for the Alipore district, which considerably increased the area controlled by the company, and necessitated the erection of a second station. In this year the company earned a nett profit of over £5,300 and commenced paying dividends.

In the year 1901 considerable extensions in the mains were carried out, and the demand had increased to such an extent that it was decided to erect a third generating station. In the year 1902 there were considerable extensions in plant and machinery and mains. During this year licences were obtained for the Howrah district, on the other side of the river. Since 1902 further licences have been obtained, and the company now control an area of over 100 square miles.

The following figures show the increase of the business year by year since 1901, from which it will be seen that the company had last year a gross revenue of £60,000 and a net revenue of £29,499.

Year.	Equivalent connections in 8c.p. lamps.	Units Sold.	Gross Revenue.	Net Revenue.
			£	£
1900	28,586	412,950	11,147	5,394
1901	56,597	962,958	23,248	8,646
1902	80,762	1,552,775	35,124	13,133
1903	121,878	2,044,681	47,139	21,587
1904	163,853	2,760,457	60,243	29,499

The following table shows the financial results and the size of the undertaking:

Year.	Capacity of Plant in kw.	Maximum demand in kw.	Miles of Mains.	Capital expended.	Dividend.
				£	
1900	754	—	26	118,266	3½%
1901	1,976	392	46	180,639	6%
1902	1,425	650	78	295,653	6¼%
1903	3,239	984	108	382,770	7%
1904	3,239	1,339	126	424,504	8%

The success of the plant is largely accounted for by the low costs of working, which are set out in the following tables:

Year.	Units Sold.	Cost of Coal per Unit.	Works Cost per Unit.
1900	412,950	1.32	3.96
1901	962,958	.546	1.31
1902	1,522,775	.569	1.94
1903	2,067,806	.47	1.18
1904	2,760,457	.42	.95

These results reflect the greatest credit on the management, the engineering staff in Calcutta, and on the contractors, Messrs. Crompton and Co., Ltd., who have been responsible for the whole of the design of the various stations, and who have kept the closest touch on the working of the plant.

In the space at our disposal it is impossible to give a complete description of the plant and the stations of this company, but the following brief notes may be of interest:

The first station was erected at Emambagh Lane. This station now contains:

Two 60h.p. Crompton-Willans generators.
Three 360h.p. „ „ „
One 360h.p. Crompton-Belliss „
Two 1,100h.p. „ „ „

There is also in hand an additional 1,100h.p. Crompton-Belliss set.

These engines are all designed for a boiler pressure of 180lb., steam being applied by four Babcock and Wilcox boilers, each evaporating 7,500lb. per hour, and four Babcock and Wilcox boilers, each evaporating 14,000lb. per hour.

The second station was erected in the Alipore district. This contains:

Two 60h.p. Crompton-Willans generators.
Two 180h.p. „ „ „
Two 360h.p. Crompton-Belliss „

The extensions in hand include one 700h.p. Crompton-Belliss set. Steam is raised in four Babcock and Wilcox boilers, each evaporating 7,500lb. per hour.

A third station is in course of erection at Ultadunga. In this station there will be installed three 400kw. Crompton-Parsons turbo-generators, with surface condensers, steam being supplied by three Babcock and Wilcox marine type boilers, with chain-grate stokers. A station is also being erected in the Howrah district, on the other side of the Hooghly, this being fitted with three 80h.p. Crossley engines, direct-coupled to Crompton dynamos, gas being supplied by a suction producer plant.

The whole of these extensions and new sets will be completed during the present year, and the total capacity of the plant will then be 5,500kw. In all the steam stations the fuel used is Bengal coal, which is equivalent to English coal of medium quality, and has a thermal efficiency of 11,500 B.T.U. per lb. In the Howrah station gas coke will be used in the producer plant.

Emambagh Lane has two chimneys, one about 150ft. high for natural draught, and one shorter for induced draught, the fans being electrically driven. The four small boilers at Emambagh Lane are arranged for hand stoking, all the other boilers on the system being fitted with chain-grate stokers. All the boilers are fitted with superheaters,

Power House at Emambagh Lane.

POWER STATION AT ALIPORE.

Emambagh Lane being run non-condensing, the other two stations being arranged for condensing. At Alipore ejector condensers are used, condensing water being taken from a nullah connected with the Hooghly river.

The circulating pumps are electrically driven, of a special reciprocating type designed by Messrs. Crompton and Company, which have been found in practice to be extremely efficient. The turbine sets now being erected at Ultadunga will be fitted with ordinary surface condensing plant. The supply is on the continuous current three-wire system at 225 volts, with 450 volts between the outers. The mains are laid partly underground and partly overhead. All permanent mains are, as far as possible, laid underground on the solid system, but in the pioneer work in new districts distribution by overhead mains has been employed on account of the low first cost. As soon as the demand justifies it, these distribution mains are to be put underground. Of the total length of 126 miles of mains, about 75 miles are underground, and 50 miles overhead.

At the present time the mains cover an area of about twenty-eight square miles out of a total area of over 100 square miles. The illustration on the previous page shows the station at Emambagh Lane. Since the photograph was taken considerable extensions have been made. Not only is the company earning good dividends for its shareholders, but also the board appear to be following a very careful policy in the matter of finance. With a capital expenditure of £424,504, the reserve fund stands at £54,592 10s. In addition, there is a balance at credit of the renewals fund account amounting to £21,815, while the balance carried forward to next year amounts to £4,720.

This account is necessarily brief, but we think we have said enough to show that the Calcutta Electric Light Company, not only in the area it controls, but also in the size of its stations and output, compares with some of our largest English stations; while the low working costs and successful financial results will doubtless be the envy of many stations nearer home.

LIFTS FOR CENTRAL STATION MAINS.

W. Sprowson and Co.

In our Transport Supplement last month we gave a brief description of Messrs. William Sprowson and Company's patent automatic push button electric lift, and during our inspection of this machine we had an opportunity of examining their car switch operated lift. The accompanying figure illustrates their standard winding engine used for both types of lift, and also the control employed for the car switch operated.

This complete machine occupies a ground space of 5ft. 6in. by 3ft. 6in. only, the apparatus being mounted on cast-iron bed-plate. For neatness in design, combined with great liberality of strength, it is unique. The armature shaft is coupled to the worm shaft in the usual way, the worm shaft half of the coupling being used as a brake drum. On the face of the drum a number of specially formed grooves are turned, giving a brake of unusual power, which is released magnetically and applied by a cluster of springs, so that in event of the failure of one or two, the brake is still left powerful enough to arrest the cage when travelling at full speed in a distance of about a foot. The worm is placed below the worm wheel, both running in an oil bath, and the teeth of the worm wheel are cut out of solid phosphor bronze, the worm shaft being of solid steel. The driving drum worm wheel and shaft are exceptionally heavy in design, the latter being provided with three bearings.

Messrs. William Sprowson and Company's patent safety gear, which is fitted to all their cages, is worthy of note. We hope on some future occasion to give a special article, accompanied by illustrations, upon this gear, which for lack of space cannot be done in this issue. Those of our readers interested in electrical lift engineering will have some knowledge of the amount of paraphernalia usually employed in safety gears. In this case the opposite extreme appears to have been reached, resulting in simplicity itself, there being only two working parts, namely, the suspension rope, which, when stretching or breaking, operates the gear, and the shaft carrying the cams which roll into the guides and arrest the cage.

We visited quite a number of Messrs. William Sprowson and Company's passenger lifts, and in each case our attention was arrested by the unique designs introduced in their cages. They appear to have struck out on entirely new lines with very considerable success.

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Our Crane Motors, of which we show a reduced illustration, are supplied from 1½h.p. to 30h.p. They are of thoroughly modern design, the outcome of much experience, and every machine carries our

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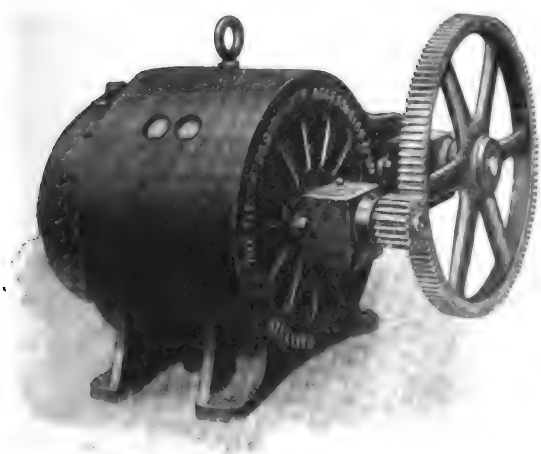

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TACHOGRAPH AND SPEED RECORDERS.

Geo. Thomas & Co.

EVERY central station engineer makes use of some form of speed counting device. A favourite type is that indicating revolutions per minute on an open circular dial, the device being mounted on the engine bed and driven by a belt from the main shaft. It frequently happens that tests are undertaken in which the speed of the machine must be accurately recorded. In such cases human agencies cannot be absolutely relied upon, as the personal factor of the observer is likely to introduce serious errors. For this reason a speed recorder rather than a speed indicator is valuable, in fact, indispensable. Naturally, apparatus of this description can only be efficiently produced and marketed at a reasonable price by specialists with extended experience in this province.

Geo. Thomas and Company, 72A, Deansgate, Manchester, have made a study of speed counting and recording devices for many years, and have placed their special experience at the disposal of users of power plant in general. They make a line of tachographs for a great variety of purposes. Type A, for instance, is a speed recorder without dial for taking temporary speed diagrams of engines, motors, and shafting. It has a range of 12 per cent. above or below the normal number of revolutions of the machine to be tested. An illustration of this device is given in Fig. 1. The records cover a space of two inches on the paper slip, and fluctuations of a $\frac{1}{4}$ per cent. can be easily read on the diagram. In place of the usual ink recorder a silver pencil can be used, but this is only recommended when the test extends over a very long period. The paper record is 112yds. long, and it is driven by a steel spiral spring working from the pendulum shaft. The speed of the paper changes in proportion to the number of revolutions of the tachograph pendulum. The type shown in Fig. 1 is suitable for an average speed of 500 revolutions per minute.

Type B, shown in Fig. 2, is intended to record very slight variations in the speed up to 3 and 6 per cent. above and below normal. Its construction is very similar to type A, but it is ranged to record more sensitive variations. It will register the fluctuations of speed in a shaft during one revolution. The speed of the paper can be varied from $\frac{1}{25}$in. to $\frac{4}{5}$in. per second. An instrument known as type C is also made which combines the functions of speed indicator and recorder. It has a large open indicating dial which is surmounted by the paper drum for the recording slip. The diagram permits measurements to be taken over twenty-four hours, and the device is very useful

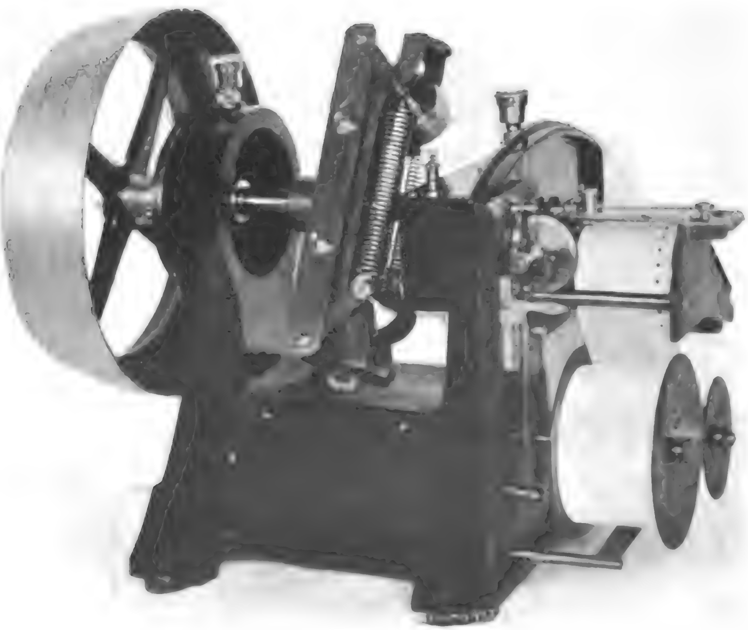


FIG. 1. G. THOMAS & CO.'S TYPE A TACHOGRAPH.

FIG. 2. TYPE B TACHOGRAPH (GEO. THOMAS & CO.).

results; by this control evils are located and rectified, and economy and efficiency are ensured.

To meet this requirement, Messrs. G. Thomas have introduced a transmission dynamometer or power weighing apparatus.

Power, developed or transmitted, is actually weighed by this dynamometer in a manner as actual and definite as that by which objects are weighed on the ordinary platform weighing machine.

The new and improved model is designed specially for textile mill use, comprising a tachometer for instantly indicating the speed (doing away with the "timing" formerly needed with the old worm counter) and a dial legibly showing the load; these two factors established, only a simple calculation is necessary to find the horse-power developed or transmitted. The apparatus is fitted with two sets of levers, and thus is available

for indicating the length of time any particular machine has been in operation. Another useful instrument is tachograph D, which is somewhat similar to type C, save that the recording slip is 56yds. long and is mounted at the side of the governor case and not above the indicating dial. The speed range is from 60 to 360 or 60 to 480 revolutions per minute, and the dial case is 12½in. in diameter. All these instruments have a very extended use, and have given complete satisfaction wherever they have been introduced. They are all of compact design, and exceedingly light, and the many purposes to which they can be placed is a strong recommendation for their use by central station engineers.

It is of vital importance that power users should take and record statistics of power (as of other commodities), thus controlling the efficiency of their machines and verifying that they are actually getting the best

for running in either direction, requiring no change; it is complete with special clutch and bushings to fit shafts varying in diameter from ¾in. to 1½in. inclusive, speed indicator or tachometer, and spare weights for use when the load exceeds the figure up to which the dial is graduated (*i.e.* 80lb.), and which weights are added in the same manner as with ordinary scales.

The apparatus has a pitch circle of two feet, *i.e.*, the driving pins describe a 2ft. circle. Example: If the tested machine shows a net weight of 50lb. when running at 660 revolutions per minute:

$660 \times 2 = 1320 \times 50 = 66{,}000$ foot pounds.

Divide by 33,000 (number of foot pounds per h.p.) = 2 horse-power.

Having got the h.p. for the frame, there obviously follow the number of spindles per horse-power (or the horse-power required per spindle), and these figures are then available for comparison with known data.

Developments of the Gas and Oil Engine.

OUR engineering forefathers pictured a great industrial Britain built up by the agencies of coal, water, and steam, but their dreams have met with only part realisation in our time. Their methods of discernment could not foresee the limits of the steam engine, so their aspirations did not rise beyond its insuperable defects. To-day, when the vitality of industry is so closely allied to electrical engineering, prime movers have come under the influence of electricity generation and consequently further progress is only possible by extracting the latent energies from coal in a more direct way than by the employment of such an intermediary as steam. Events have been slowly tending in this direction for many years past, and we appear now to be approaching the point when steam as a prime power agent will be discarded in favour of gas engines and plant.

Such a result is not difficult to imagine. Great Britain is a great manufacturing country, and her factories' wheels require power as do her railways and ships. While other nations with the natural benison of water power are now using this in the form of electrical energy for every industrial purpose, she must rely on her coal to furnish the same means for the same ends. For many decades these resources have been almost ruthlessly sapped and wastefully employed. At this moment some millions of horse power are being let loose from coal and steam, with a minimum of power and a maximum of waste. To reverse this order of things recourse must be had to the gas engine combined with the dynamo electric machine. Such intermediate apparatus as water and boilers, with their numerous accessories, must now figure no longer in the electric power house, and the length of the gap between the coal and the electrical energy will be at once materially reduced. The next step will be the elimination of engine and dynamo from the series; but that is not yet.

At the moment there are something like thirty makers of gas engines in sizes from 100 to 3,000b.h.p. in this country, on the Continent, and in America. The limits of sizes mentioned of course exclude the smaller makers who are more numerous. These firms have been seriously exploiting the large gas engine for many years, and we are on the eve of developments which should give it an unassailable position among prime movers for many years to come. Combined sets, of enormous output compared to former machines, have already been built and others of sizes up to 5,000h.p. are in course of construction and will shortly be in commission.

Space does not permit us to dilate on the many economies possible with gas as compared with steam plant, and our readers must judge of the present position of the art by the types of modern gas plant depicted in the Supplement following. Although the obstacles in the way of the complete supersession of the steam by the gas engine are by no means surmounted, so determined are the efforts of engineers to improve the latter to a degree bordering on perfection, regardless of all cost, that the outlook for their complete success is promising indeed.

The oil engine is also a prime mover to be reckoned with in the future, and the two well-known types described in the Supplement are cogent with possibilities and open up vast avenues to cheap power.

There is just a danger that the suction type of plant may prove a serious competitor to the electro-motor, but a firm effort to generate electric power at rates which cut below even the suction plant should calm any fears of such competition. With the large gas power station at the pit's mouth, generating and distributing electrical energy over wide areas, it may become cheaper to buy electricity than coal, and when the extreme flexibility of the electro-motor is considered this seems the only possible outcome of events.

WESTINGHOUSE GAS ENGINES.

In the development of prime movers for dynamo driving the Westinghouse Companies have done yeoman service, and the records of progress in this particular field simply bristle with their exploits. The name Westinghouse is already "writ large" on the steam engine, whether reciprocating or rotary, from the very earliest days of the art till the present time, and, in the gas engine domain its reputation for pioneer work is in no danger of becoming eclipsed. The first high speed gas engines for direct coupling to electric generators emanated from Westinghouse shops, and the high speed ideal in larger sizes bids fair to meet with successful attainment at no distant date and under the same auspices. It is interesting to note that gas engines for powers at one time thought impossible in the design adopted are constructed at Trafford Park Works, Manchester, where special plant for their production is in active operation.

The engine itself is doubtless a familiar object to many of our readers, as a considerable number are to be seen in regular commission in numerous power plants both public and private in the United Kingdom. Among particularly successful plants we may mention the Walthamstow U.D.C. Metropolitan Carriage and Wagon Co, Birmingham, Cadbury's Cocoa Works, Bournville, Brymbo Steel Works, Heysham Harbour, &c.

The illustrations which we give show two types of Westinghouse gas engines. Fig. 1 represents one of the now well-known three cylinder single acting engines, a type which is built up to 250b.h.p. capacity for operation on either illuminating or producer gas. They are of simple construction, with few moving parts, and are substantially built throughout. The crank case is totally enclosed and contains an oil bath, into which the cranks dip, giving continuous and liberal lubrication to the heaviest moving parts. Operating on the Beau de Rochas, or four cycle principle, with throttle control, the speed regulation is excellent, and allows of direct coupling to either continuous current or alternating current generators, which can be operated in parallel with reliability. The efficiency of these engines, together with the speed regulation obtained, has led to their large adoption in central station work. At Walthamstow some 2,000h.p. is installed

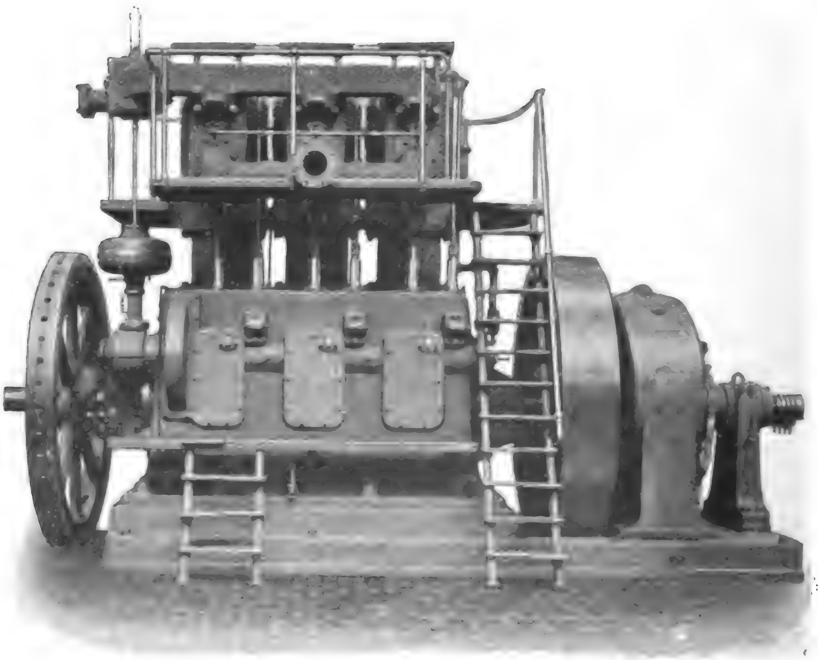


Fig. 1. 250h.p. Westinghouse High Speed Gas Dynamo.

with further extensions now being carried out. Faversham and Limerick are other central stations where this type of the Westinghouse gas engine are in regular operation.

The engines are started by means of compressed air and the compressing plant is very simple, varying in arrangement according to the locality and number of main engines. The engines can be started by one man. One cylinder is, for the moment, converted into an air motor cylinder, by altering the function of the gas and exhaust valves, until an explosion takes place in one of the other cylinders to which the gas has access. Once an explosion is obtained, the compressed air is cut off and the valves of the cylinder which has been temporarily used with air for starting are caused to operate normally by the movement of a lever. The gas is then admitted to this cylinder and the engine is in full operation. The compressed air is stored in reservoirs of proper capacity and is pumped up to the desired pressure after the engines are started.

The cylinders and heads are properly water jacketed, with suitable openings provided to allow of cleaning out any deposits. Ignition is effected by means of an electric spark, and a complete igniting outfit is furnished with all engines. The bearings throughout are of ample dimensions, those of the crank shaft and crosshead pins being adjusted by means of wedge bolts to take up wear.

Simplicity of design is one of the striking features of the engines. Their noiselessness, absence of vibration, and constant speed render them equal to the best class of steam engines, while their wide adoption for exacting duties is a high testimonial to their reliability.

Fig. 2 shows the Westinghouse Company's two cylinder double acting gas engine of 550b.h.p. and the resemblance it bears to a modern vertical steam engine will be at once noticed. The particular engine illustrated has been built for the driving of a large mill by means of ropes.

In the main the engine closely follows on the lines of a vertical steam engine, though of heavier construction for an equivalent output. The crank shaft is carried in two self-aligning bearings situated in the massive sole plate castings. The housings forming the crosshead guides spring from these sole plates, and carry the cylinders and superstructure, while the cranks are overhung. The horizontal cam shaft is driven by gearing, the motion being transmitted from the crank shaft by a vertical shaft passing inside the casing seen on the lower platform.

The piston and piston rods of these double acting engines are water cooled, the water being introduced and withdrawn by means of a well-designed arrangement of rocking levers. The cylinders and their covers are also water jacketed, and means are provided

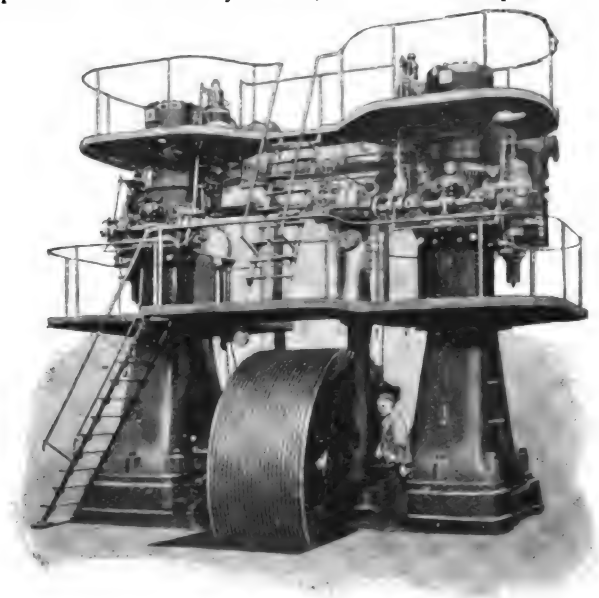


FIG. 2. 550B H.P. WESTINGHOUSE VERTICAL GAS ENGINE, SUITABLE FOR DIRECT DYNAMO DRIVING.

for taking care of expansion and contraction of the cylinder walls.

The inlet and exhaust valves are situated on the sides of the cylinders, where they are readily accessible—indeed, every part of the engine can be got at very easily. The valves are operated by rollers, bearing on the cams and levers.

Throttle control is adopted on this type of engine, with the same good results as are obtained with the single-acting engines, and the ignition is also by electric spark. Convenient platforms and ladders are provided around the engine, and the openings in the housings about the reciprocating parts are covered in with gauze frames.

TWO CYCLE DOUBLE-ACTING GAS ENGINES.

SOME time ago Messrs. Mather and Platt, Ltd., of Salford Iron Works, Manchester, took up the manufacture of the Körting type of gas engine. This engine is of the double-acting two cycle type, and is therefore built on the same lines as an ordinary double-acting steam engine. Each side of the piston receives an impulse every alternate stroke, *i.e.*, there are two impulses per revolution, or four times as many as in the single cylinder "Otto" cycle engine.

The front end of the piston rod is carried through a stuffing box, and is connected to an external crosshead in the ordinary way. This arrangement is of great value, as it obviates the difficulties arising from the heating of the internal crosshead pin.

On the other hand, the outside crosshead has the further advantage of doing away with undue wear and tear of cylinders and pistons. In this engine the charge both of air and gas is supplied to the combustion cylinder by independent charging pumps, which in one stroke supply both the scavenging and explosive charges to the power cylinder, and it is owing to the adoption of these independent pumps that the engine acts on the two cycle instead of the four cycle system. The air pump thoroughly sweeps all burnt products through the exhaust ports and thus prevents pre-ignition of the incoming charge by contact with the hot gases remaining in the cylinders. This sweeping out of the burnt products also prevents the choking of the exhaust ports. After this scavenging charge of pure air, the gas pump, the discharge of which takes place later than that of the air pump, sends a supply of gas into the combustion cylinder, which, mixing with the air, forms the combustible mixture for the next power stroke. The exhaust ports are then closed by the return stroke of the double-acting piston, the mixture is compressed and ignited electrically, and the explosion takes place. Regulation is effected by altering the quantity of the mixture admitted to the power cylinder, though the quality of the mixture is to be maintained practically constant. This method of regulation is a great improvement on the "hit" and "miss" principle. The engine is started by means of compressed air which can be supplied from a small air compressor fitted with a reservoir. The most careful attention has been paid to the question of cooling, and the system of water jackets is carried to the fullest possible extent.

Fig. 1 shows a 750b.h.p. engine direct coupled to a 500kw. dynamo, and of the Körting design, in which the pumps were on the opposite side of the engine to the valve gear. In a more recent engine, illustrated in Fig. 2, the design has been altered with a

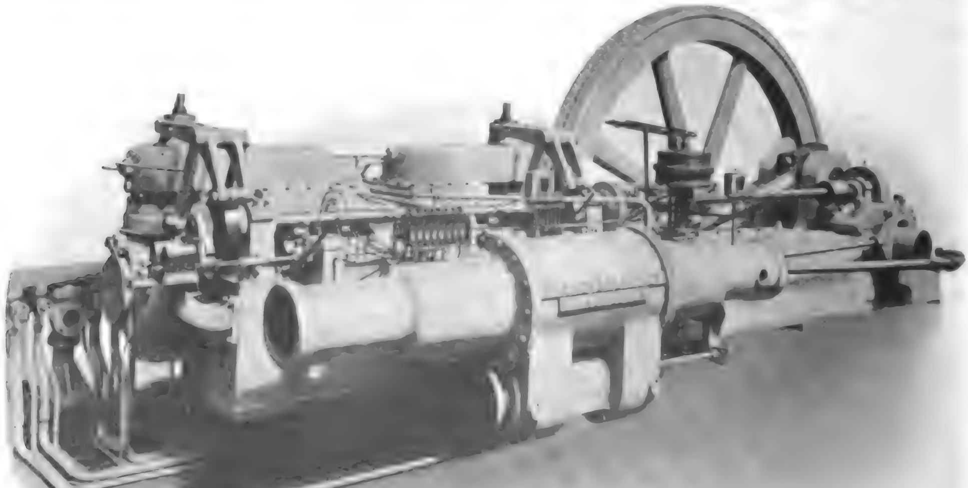


FIG. 2. KÖRTING GAS ENGINE. LATEST TYPE BY MATHER AND PLATT.

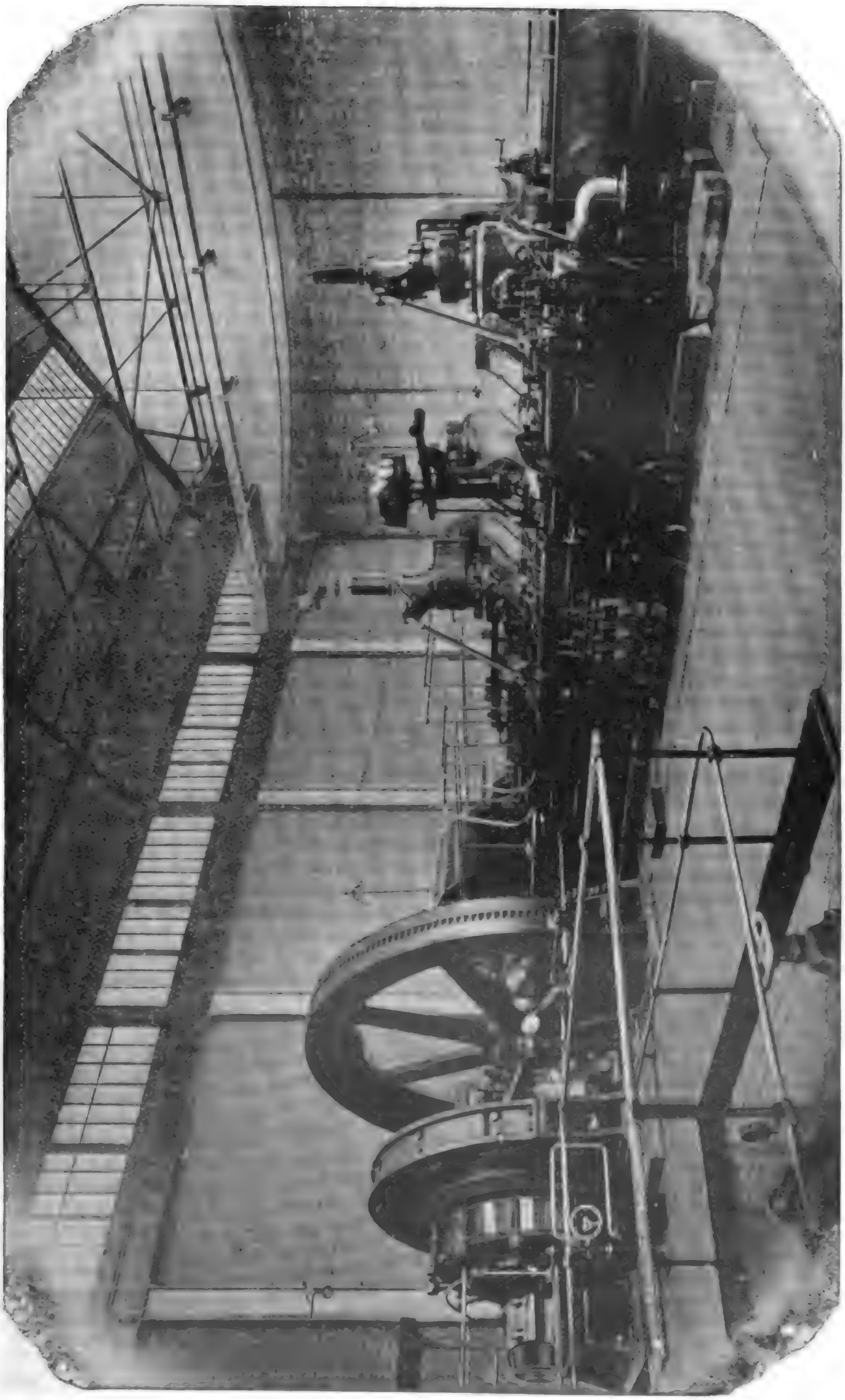


Fig. 1. 750B.H.P. Gas Engine and 500KW. Dynamo by Mather and Platt.

view of bringing all the working parts to one side of the engine, and decreasing the width in the floor space required. Thus it will be seen that the cam shaft is brought to the same side of the engine as the pumps. Whilst the air pump is still of the double-acting type with piston valves actuated by an eccentric and rocking lever the single double-acting gas pump has been replaced by two single-acting pumps, one at either end of the air pump, and by using trunk pistons in these the separate valve gear has been eliminated.

We may well reiterate here the advantages which the makers claim for this engine :

1. Perfect scavenging with cool, fresh air, whereby pre-ignition by contact with products of combustion is entirely prevented and lubrication much facilitated.

2. Absence of heavy exhaust valves, which are usually a source of weakness, and liable to fail in their action owing to the intense heat to which they are subjected by the passage of exhaust gases, and to become fouled by products of combustion.

3. Removal from the power cylinder of up and down strains due to the resultant of impulse and resistance on the crosshead pin, which in this case is entirely outside the cylinder: ease with which the crosshead pin is kept absolutely cool and easily lubricated, giving a marked advantage over trunk piston engines.

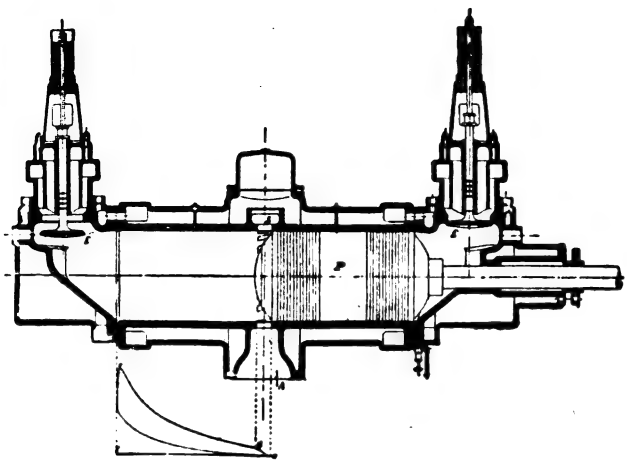


FIG. 3. SIDE SECTION THROUGH KÖRTING GAS ENGINE. MATHER AND PLATT.

4. By obtaining an impulse each stroke, the diameter of the cylinder is just half of what is required for an "Otto" cycle engine of the same power; the load on the working parts and the weight of the same are therefore small compared to the power given out; also, since the contents of a cylinder vary as the square of its diameter, but the surface only varies directly with the diameter, it follows that for a given amount of jacket water the cooling results are more satisfactory with the small than with the large cylinder.

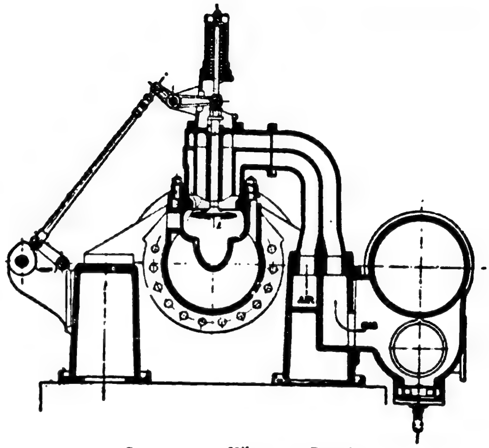


FIG. 4. END SECTION OF KÖRTING GAS ENGINE, SHOWING VALVES. MATHER AND PLATT.

5. Great steadiness of running, owing to the fact that in the case of a double-acting two cycle engine four times as many impulses are transmitted to the crank shaft as are transmitted to the shaft of a single cylinder four cycle engine. Lighter fly-wheels can therefore be used and unnecessary weight and friction are thus avoided, while as steady running and as high a degree of cyclic regularity are attained as with a steam engine.

6. The engine can be started up after standing far more quickly than a steam engine which has been shut down; lubrication is forced and practically automatic throughout; the design generally lends itself to hard and continuous running, and should inspection be necessary it can be effected with great ease and in a very short time.

A number of these Körting engines have been installed in Great Britain by Mather and Platt, Ltd., and on the Continent and in the United States of America some very large installations are in operation.

COCKERILL TYPE GAS ENGINES.

Richardsons, Westgarth & Co., Ltd.

A FIRM of enterprising gas engine makers in this country is Richardsons, Westgarth and Co., Ltd., of Middlesbrough, who have purchased the sole right of making and selling the Cockerill type of engine in the United Kingdom. Our readers will doubtless remember that the Société Anonyme John Cockerill of Seraing were the pioneers in making large blast furnace gas engines. Messrs. Richardsons, Westgarth and Co., Ltd., have already supplied upwards of 10,000h.p. of gas engines in this country, including an installation of 5,900 i.h.p. for the Cargo Fleet Iron Co., of Middlesbrough. An illustration of this important plant is shown in Fig. 1. Each of these engines weighs about 190 tons and operates at 75 revolutions per minute with 30 ton flywheels; each has one single acting gas cylinder, 51¼in. diameter by 51in. stroke, working on the Otto cycle. They are started either from a benzine carburetter or compressed air, the engine being turned round by an electric barring motor. The ignition and barring motor circuits are so arranged that firing does not commence until the barring motor is cut out of gear. Water jacketing is made very complete, and in addition to the cylinder includes pistons, piston rods, exhaust valve chamber, &c. The water circulating system is so arranged that should the supply fail at any time the electric ignition is disconnected. Hit and miss governing is employed except when the inlet valves are on the top of the cylinder, when the cut-off of the gas supply valve is varied by a powerful ball governor. The crank shaft and other important bearings

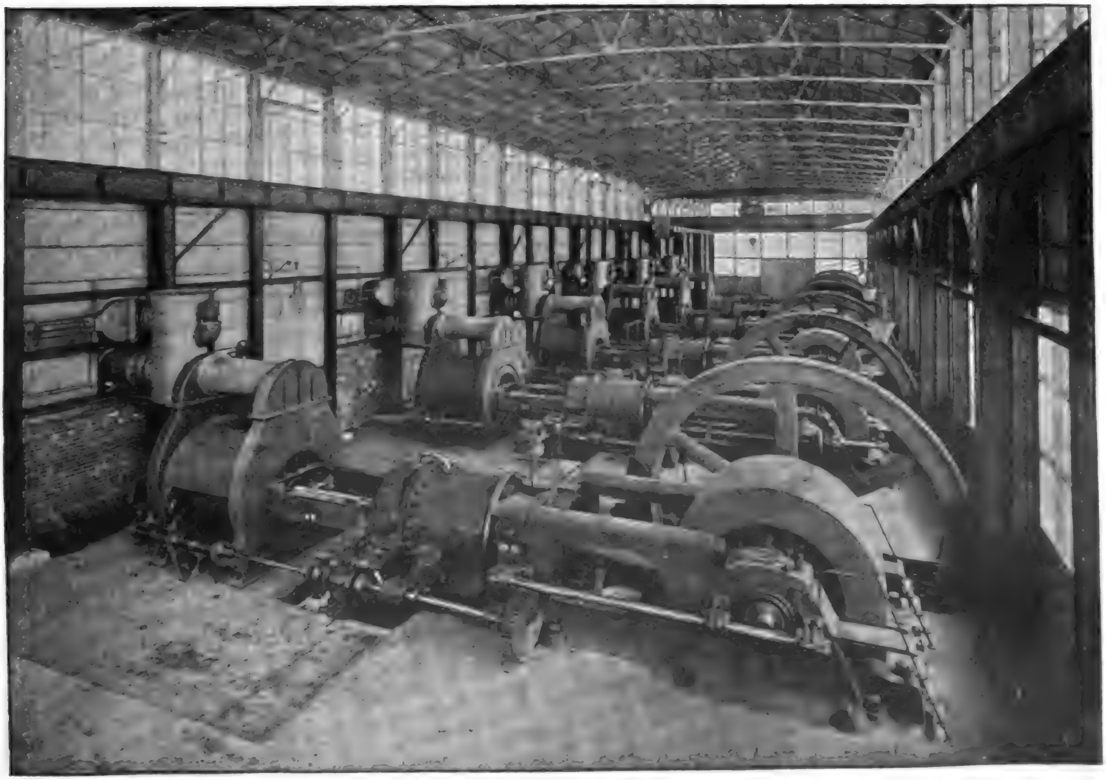
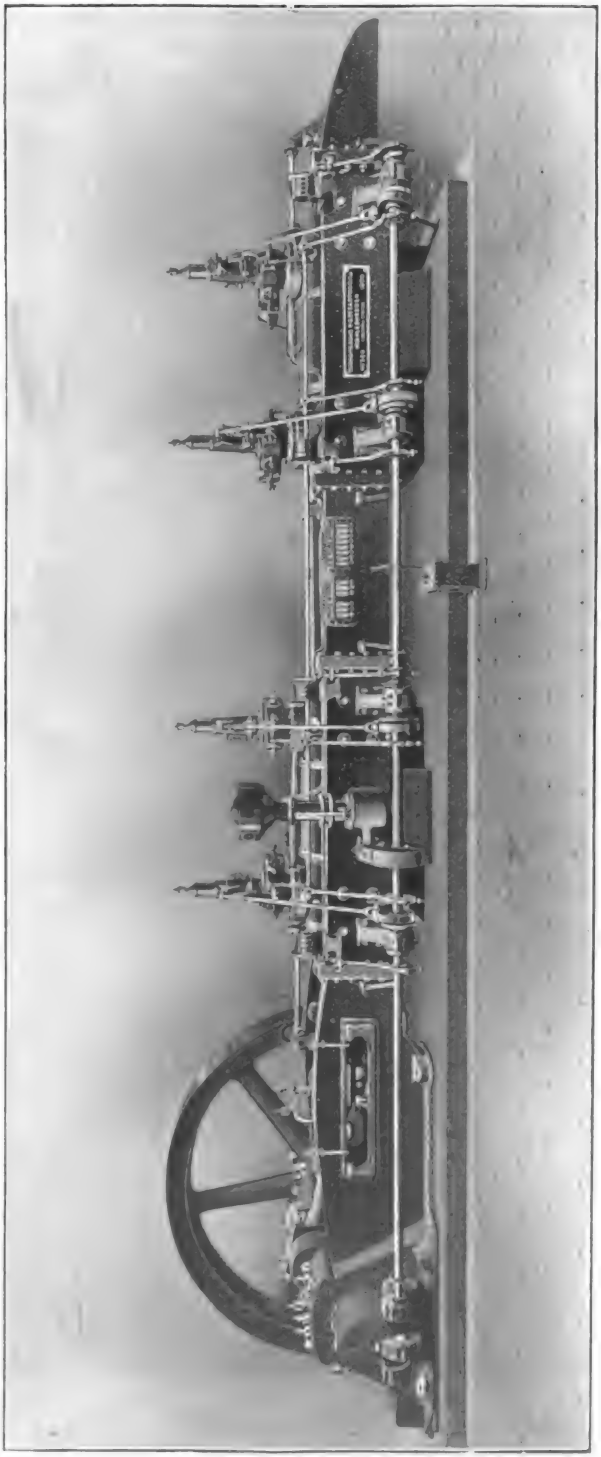


FIG. 1. 5,600I.H.P. INSTALLATION OF COCKERILL GAS-BLOWING ENGINES CONSTRUCTED BY RICHARDSONS, WESTGARTH AND CO., LTD., AND ERECTED AT THE CARGO FLEET IRON WORKS, MIDDLESBROUGH.

(Another set has been added since the above was taken.)



500 I.H.P. Tandem Double Acting Cockerill Gas Engine, by Richardsons, Westgarth and Co., Ltd., Middlesbrough.

have ring lubricators, and the piston and other internal parts are lubricated under pressure from a pump with sight feed connections.

Fig. 2. illustrates a 500b.h.p. tandem double acting gas engine recently built by Richardsons, Westgarth and Co. for the electric station of their Middlesbrough works. This engine is of Cockerill type, having cylinders $23\frac{5}{8}$in. diameter by $31\frac{1}{2}$in. stroke, and is arranged to drive a Brown Boveri continuous current generator direct coupled to one end of crank shaft at 135 revolutions per minute. The gas for the engine is generated in a Mond-Talbot producer, and passes through one of Theisen's patent centrifugal cleaning apparatus, also manufactured by Richardsons, Westgarth and Co.

As will be seen from the illustration, all the latest improvements have been embodied in this design; the gas and air valves are placed on top of the cylinders, the exhaust valves only being placed below. This simplifies the valve gear considerably, one cam on the side shaft operating each set of valves, and making all working parts readily accessible. Loose covers are also fitted to the cylinders to facilitate overhauling and enabling the piston to be drawn for examination within a few hours.

Another special feature is that free expansion and contraction is allowed for in the longitudinal side frames carrying the cylinders. These consist of two continuous girders from the crank shaft to the end of the engine, the gas cylinders being secured to the frames at one end only, thus allowing expansion and contraction to take place, whilst avoiding internal strains being set up in the cylinders themselves.

MASONS GAS POWER PLANT CO., LTD.

THE progress and development of power gas engineering during the past few years has but few parallels in the history of engineering. Numerous plants of comparatively small size have been working for a number of years with success, using producer gas made from anthracite coal or coke, but, owing to the considerable cost of the high-class fuel required, power gas plants of large sizes were not generally favoured by engineers, the economy in comparison with steam power plants being questionable. It was not until it was successfully demonstrated that clean gas (which is absolutely essential for the operation of gas engines), free from tar and dust, could be generated from bituminous coal that engineers directed their attention to the installation of large power gas plants, and the building of gas engines large size to operate with producer gas. The great advantage and economy of power gas plants, using bituminous coal and other cheap fuel, is now practically universally conceded by leading engineers.

The Duff-Whitfield Producer.—The following definition of a gas producer may be accepted without question. "A gas producer is an apparatus for converting the whole of the combustible in the coal into a combustible gas," and, gauged by this definition, the results yielded by the Whitfield system place the apparatus in the very forefront of the lists of gas producers. The characteristic feature of the Whitfield system, exploited by Masons Gas Power Co., Ltd., Levenshulme, Manchester, is found in the method of dealing with the volatile products from the coal. In ordinary practice this volatile matter, consisting mostly of tar vapours, passes away mingled with the hot producer gas, but condenses on the first contact with a colder surface, and entails considerable trouble and

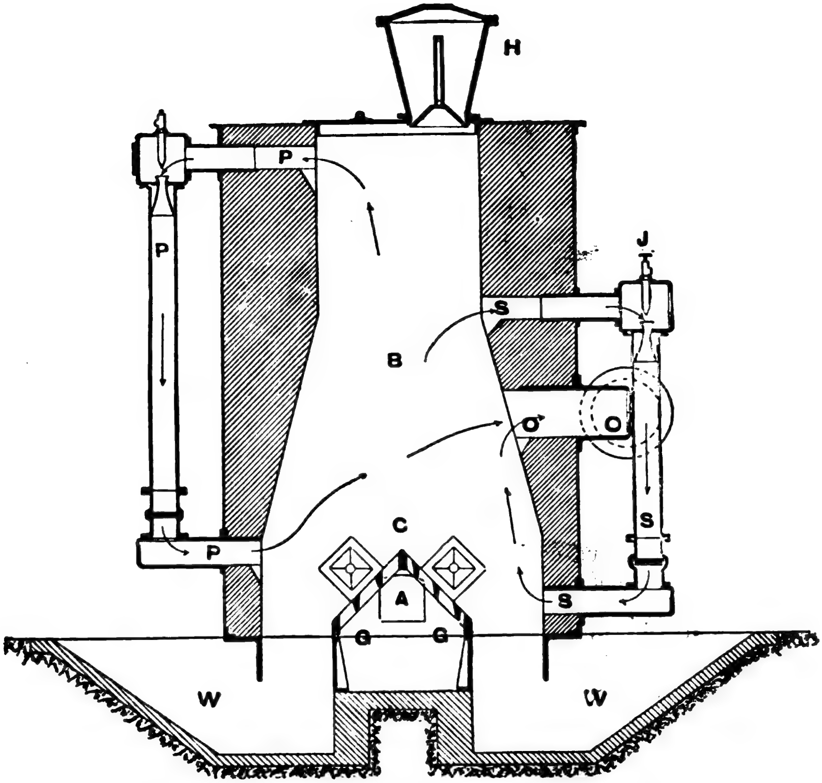
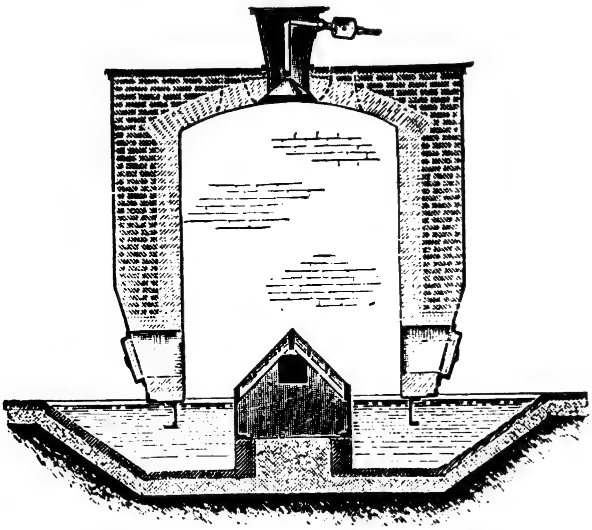


FIG. 1. SECTIONAL VIEW OF DUFF-WHITFIELD GAS PRODUCER.

elaborate apparatus for so complete a removal from the gas as is demanded in the case of its use in gas engines.

Fig. 1 represents a section of a generator or gas producer arranged on this system. In this, H is the charging hopper by which the coal is fed into the body, B, of the producer, G is the grate or grid from which the fire proceeds, A being the inlet for the saturated air required for combustion of the solid carbon. O is the main outlet for the gas from the producer, whilst P is the higher or primary circulating pipe, or circulator, and S is the lower or secondary circulator by means of which the tarry hydrocarbons are withdrawn from the upper portions of the producer body by the action of the steam jets, J, and forced into the incandescent mass of fuel in the zone of combustion, C. W is the water trough by means of which the refuse or ash is withdrawn periodically from the producer without interrupting the production of gas and without loss of heat.

When ordinary bituminous coal is used, the producer is filled as far as the feeding hopper will conveniently allow, and when the lower portions of the fuel are raised in temperature to incandescence, the more volatile vapours are drawn off from the top by the primary circulator and injected into the highly heated portions of the fuel at the lower part as shown. The height of the fuel is kept fairly constant for obtaining uniform results, and the secondary circulator draws off at a lower level the less volatile products and those which may have escaped the primary pipe, and delivers these also to the hot portion below. The solid carbon is burned on the grate by means of an air blast, but the hydrocarbon vapours are injected into the incandescent carbon with steam but without additional air, and when these are decomposed the hydrogen from the hydrocarbons and the steam passes off free, whilst the carbon of the hydrocarbons and the oxygen from the steam form carbonic oxide.



Section of Duff Gas Producer.

The Duff Gas Producer.—Undoubtedly the most largely used of all the recent gas producers is the Duff patent, and it would be difficult to imagine a simpler design, or one better suited to the end in view.

Fig. 2 illustrates Duff's continuous gas producer. It is a water-bottom producer, the trough running at right angles to the ridge formed by the A-shaped grate or blast grid. This "grate" is the outstanding feature of this producer. The fuel is mostly supported by the ash in the water trough, and the air is distributed to the fuel over a considerable area. The peculiar form of this grid gives it the power of distributing the blast evenly throughout the mass of the fuel from the centre, and at the same time without allowing the escape of the free air up by the walls of the producer. The air and steam ascend directly upwards at the centre of the producer, and, while distributing a portion outwards towards each side, the blast is not forced downwards or horizontally to the walls, or deflected in any way from an upward direction. Producers of this design can work successfully—up to about 30cwt. per hour—and give best results when gasifying coal with a view to recovering the maximum of ammonia from its nitrogen. Each particle of the nitrogen when set free from its carbon combination should be enveloped in an atmosphere of hydrogen for union, and of steam for preservation of the ammonia thus formed : and the more complete the distribution of the air and steam through the mass of the fuel, the better is the prospect of that condition being fulfilled. This equal distribution of the air ensures a more complete combustion than is obtained in other producers.

SIMPLEX AND INDUSTRIAL GAS PRODUCERS.

The Industrial Engineering Co.

The gas producing plant of the Industrial Engineering Co., of Hyde, Manchester, are worthy of special attention as they possess distinctive features which contribute largely towards the reputation they have made. We were recently afforded facilities for viewing the manufacture of gas producers at the company's works at Hyde, and were much impressed with the extensive character of the shops, their equipment, and the amount of work going through this particular department.

The company have specialised in gas plant manufacture for several years, and claim to be the first makers of suction gas plants in this country. They have developed this type to a very considerable extent, and with the most encouraging results, making plants of all sizes, especially for colonial use. In addition they have introduced a novel form of cheap fuel producer for which they claim no special tar extracting devices are needed in the case of coal, and which will economically produce good gas from sawdust, peat, woods, &c. Fig. 1 illustrates the last-mentioned plant, and Fig. 2 gives a section through the generator and an outline of its accessories. The producer comprises an annular steel shell lined with special firebrick, closed completely at the floor line. Near the centre is the firing door, and at the bottom

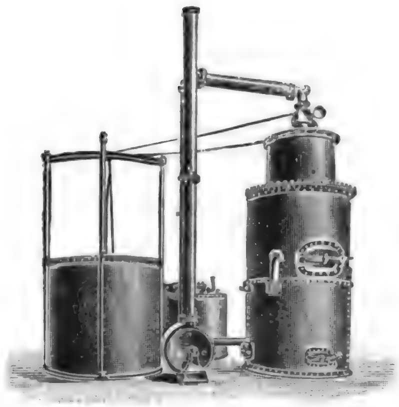


FIG. 1. EXTERIOR VIEW OF SIMPLEX PRODUCER.

is the grate specially shaped to ensure complete combustion of the fuel. The manufacture of the gas is conducted on what is known as the "blow and make" principle, which takes place in the following cycle: the fan seen on the right of the illustration acts as an exhauster, and draws air through the fire from below the grate; this air is admitted just below the firing door, and traverses an annular space between the firebrick and shell, becoming heated in its passage; the fire is at once drawn up and gas is produced. At this moment the fan is shut

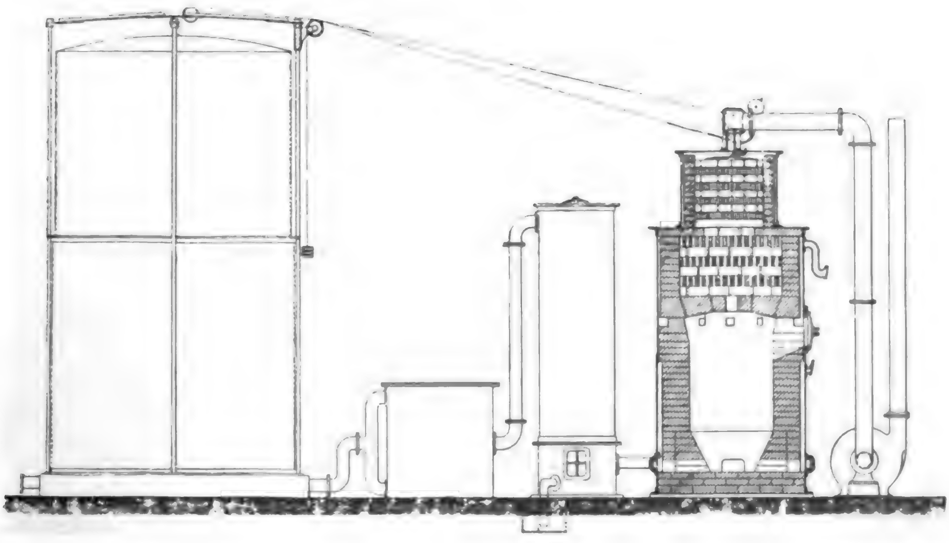


FIG. 2. SECTIONAL ELEVATION OF SIMPLEX GAS PLANT FOR CHEAP FUELS.

off and water is admitted at the grid-like openings visible above the fuel level in the illustration; the heat of the producer and gases converts this water into steam, the pressure of which forces the gas through openings (seen above the firing door) into the space between the shell and producer lining; it is thence forced to pass through the hot zone of the grate, where the liquid hydrocarbons become graphitised, and in this state are readily removable in the washer, which constitutes the next stage of the process. The absence of complex and frequently inefficient tar extracting devices in this arrangement is accounted for by the method

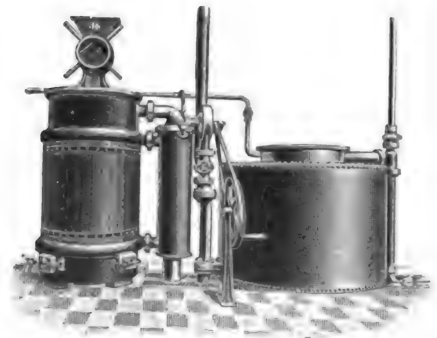


Fig. 3. Industrial Suction Gas Producer.

adopted of passing the gaseous vapours through the hottest part of the producer, near the fire, where the high temperature changes their structure and thereby facilitates the removal of elements detrimental to the working of the engine. The graphite by-product is a valuable marketable commodity, and is an item which may be accounted among the generator's economies. After leaving the washer, which is of simple construction, the gas passes to the holder by way of a sawdust filter. It may be mentioned at this juncture that the process of "blow and make" is regulated by the gas holder (in the design illustrated), which opens and closes the air and water valves at the proper times. The periods can be adjusted to suit the requirements of the consumer, and any desired quantity of gas can be obtained. Doors are provided below the grate which allow of clinkering during the blowing period, and as the draught is induced no flames are emitted.

The quality of the gas has been found to be of high calorific value, and the following is an average analysis:

CO_2	6.0 per cent.
C_2H_4	.7 per cent.
CO	31.3 per cent.
CH_4	3.3 per cent.
H	46.0 per cent.
N	12.7 per cent.

This is equal to a calorific value of 312 B.T.U.

Any desired output can be obtained by increasing the number of generators and operating them in conjunction with a common delivery pipe.

In Fig. 3 is shown the industrial suction gas plant, which is a neat combination occupying small space. It comprises generator and air regenerative heater, vaporiser, suction fan, and washer. The air regenerator is a special feature by which the air is made to traverse the hot surfaces of the producer, whence it emerges, and after mingling with the steam produced in the vaporiser, is drawn through the fuel by the suction of the engine. The vaporiser is a specially efficient form, comprising a tube with a long spiral cast on its outer surface and longitudinal ribs on its inside. The hot gases traverse the interior, and water trickles down the exterior, leaving it in the shape of steam, in which condition it mixes with the hot air as before mentioned. This form of vaporiser has been found highly efficient, and it quite dispenses with the necessity for a separate boiler.

The plant is started up by a hand fan in the usual way, and continues to supply gas automatically as the engine furnishes the suction requisite to its continuous operation. The producer uses approximately .8lb. of coal per b.h.p. per hour. The cost of .8lb. of fuel is given below for various prices of coke—

Price per ton	18/-,	20/-,	22/-,	25/-,
Cost of .8lb. of coal in pence ...	.072,	.085,	.094	.107,
Price per ton ...		28/-,	30/-,	35/-,
Cost of .8lb. of coal in pence		.12,	.128,	.149.

This table will be found useful in approximately estimating the yearly coal bill for this class of plant. Thus, supposing the engine is 30b.h.p. and runs 50 weeks for 54 hours per week, and the coal costs 25s. per ton, then

30b.h.p. × 50 weeks × 54 hours
= 81,000b.h.p. hours at .107d. per b.h.p. hour
= £36 per annum.

DOWSON GAS POWER PLANT.

Mr. Dowson was the first to devise a simple gas plant to serve gas engines, and many more engines are now working with Dowson gas than with any other producer gas since introduced. This combination of gas engine and gas plant now has a recognised position among engineers and manufacturers in all the leading countries, and its future cannot fail to be important, seeing that it follows the true lines of converting as high a percentage as possible of the heat energy of the fuel into useful work.

The suction type of Dowson gas plant is the most recent, the suction in the engine caused by the out-stroke of the piston being used to draw air and steam through the fire in the gas generator. The gas is made by passing a mixture of superheated steam and air through the incandescent fuel, as in the other types of Dowson gas plant.

The gas is made as quickly as it can be consumed, and the engine itself governs the rate of producing the gas, to suit its own varying consumption. A special device is used for regulating automatically the production of steam required for making the gas.

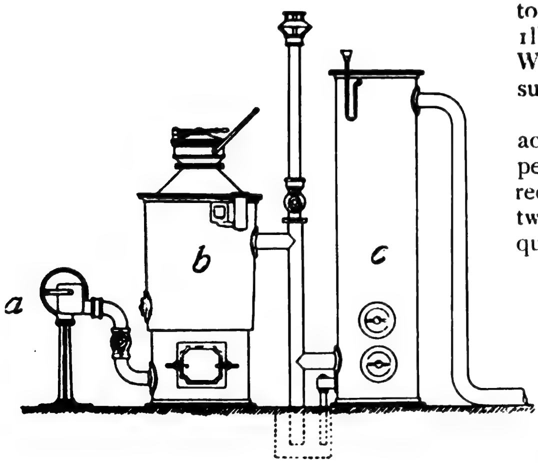
Every endeavour has been made to work on the heat regenerative principle. In the suction plant, for instance, all the air used for making the gas is heated by waste heat, as well as the superheated steam required for making the gas. The fuel which is to be converted into gas is also heated by waste heat before it reaches the combustion zone. Throughout the apparatus the loss of heat is therefore reduced to a minimum, and the efficiency is exceptionally high.

While the engine is working there cannot be any escape or waste of gas, as there is a partial vacuum in all parts of the plant and in the piping

This plant was specially referred to in Mr. Dugald Clerk's "James Forrest" Lecture, at the Institution of Civil Engineers, on April 21st, 1904. It is remarkable that with a 40b.h.p. plant worked with ordinary commercial anthracite, the actual heat efficiency was proved to be as high as 89 per cent. In other words, only 11 per cent. of the heat energy of the fuel was lost in the process of making a cheap gas suitable for driving a gas engine.

With an engine suitably adjusted, the consumption of small anthracite peas ($\frac{3}{8}$in. to $\frac{3}{4}$in. cube) is guaranteed not to exceed 1lb. per b.h.p. per hour, under full load. With small coke of good quality the consumption is about 1$\frac{1}{4}$lb. per b.h.p. per hour.

With anthracite peas at 20s. a ton, the actual cost of fuel is about one-tenth of a penny per b.h.p. per hour. The labour required does not exceed one man for two hours per day. With a suction plant the quantity of Dowson gas equivalent to 1,000

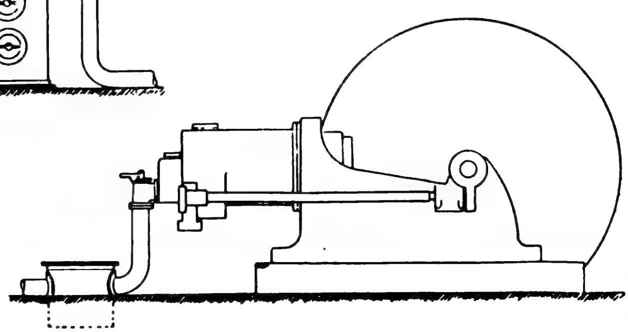


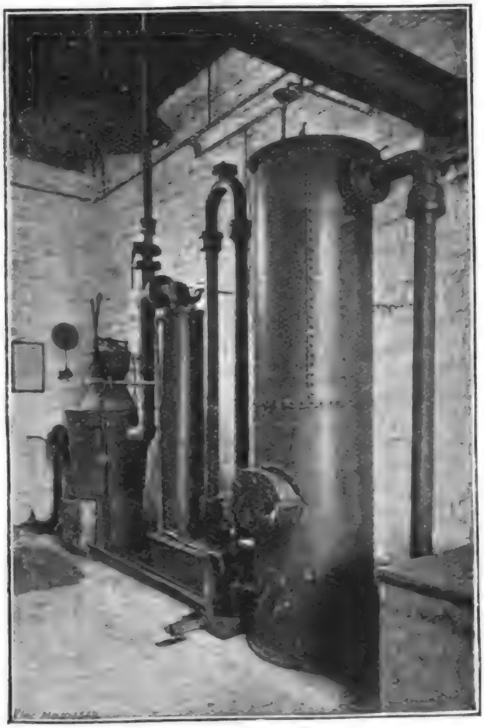
Dowson Suction Gas Plant.

a, Starting Fan.

b, Generator.

c, Scrubber.





INSTALLATION OF DOWSON SUCTION GAS PLANT.

cubic feet of ordinary town gas costs only 6d. to 8d., including fuel, wages, and repairs. This is about 75 per cent. less than the usual cost of town gas.

Stand-by Losses.—Careful independent investigations have shown that at four different places Dowson gas generators, ranging from 100 to 375b.h.p. each, during long stand-by hours, consumed an average of only 3lb. per hour, while gas of good quality could be ready for use in about ten minutes.

Equally competent authorities have shown that in various types of steam boilers, ranging from 150 to 500b.h.p. each, the stand-by loss is not less than seven times greater than the above figure for a Dowson gas generator, and in seven cases it was from 15 to 60 times greater.

No Loss from Condensation.—A further important advantage of gas is that it does not condense or lose power on its way to the engine: on the contrary, the more the gas is cooled the better it is for the engine, as each charge of gas which enters the cylinder is more dense, and has consequently greater energy. With steam the condensation in the pipes, &c., is considerable: with gas there is no such loss.

No Leaks, as with Steam.—It is easy to prevent leaks of gas from the piping, owing to the low pressure of the gas, whereas with steam there is often much loss and inconvenience on this account. With the suction plant there *cannot* be a leak of gas when the engine is working.

Saving in Shafting and Engine Power.—As the gas can be conveyed in pipes any distance without condensation or deterioration, there can be a separate engine in each department of a large factory, with light shafting for each, and the wasteful plan of driving the whole of a large factory by one engine, placed near the boilers, can be avoided.

Repairs.—The low cost of repairs is a special feature of this system. It varies somewhat, but the following may be taken as approximately correct with the original type of Dowson plant:

For	100h.p.	plant, about	£4	per	annum.
,,	200 ,,	,, ,,	£9	,,	,,
,,	300 ,,	,, ,,	£12	,,	,,
,,	400 ,,	,, ,,	£15	,,	,,

With the suction plant the repairs are still less.

This is very much less than the repairs and cleaning of steam boilers of the same power. Returns show that in electrical installations the repairs and maintenance of Dowson gas plant, engines, and electrical plant average about .05d. per unit generated.

Water Consumption.—The quantity of water required for a gas plant is about half a gallon per h.p. per hour. With steam power it is usually about four times more.

Power for Generating Electricity.—The Dowson gas power is used extensively in driving dynamos for electric lighting and the transmission of power electrically.

COMPARISON OF STEAM AND GAS POWER.

Steam Power.—Up to 50h.p. the fuel consumption in practical work is not less than 4 to 8lb., and above that power seldom less than 3lb. per. b.h.p. per hour at full or nearly full load.

Dowson Gas Power.—From 10h.p. up to any size the fuel consumption in practical work is guaranteed not to exceed 1¼lb. of coke or 1lb. of anthracite nuts or peas per b.h.p. per hour at full or nearly full load.

THE DIESEL OIL ENGINE.

Most people have heard something of the Diesel oil engine, but we should think few have any idea of the extent to which it is in use. We confess we, who have always viewed the engine with favour and referred to it on several occasions in our columns, were recently surprised to learn that within the last four years the sales have so extended that there are in use at present nearly 2,000 engines, aggregating about 100,000h.p.

Nor is this all, for one of the most notable features of the orders recently supplied, and now in hand, is the marked increase in the power of individual engines. At first engines were made in all sizes from 8 to 40h.p. Now the principal demand is for 75 to 500h.p. engines, and much larger units are being made to meet the inevitable demand at an early date for outputs of 800 to 1,500h.p. Unlike all other oil and gas engines the Diesel is not an explosion engine, as the combustion takes place gradually, and its running therefore is very steady and smooth. Owing to this and its good governing, and the power to adjust the speed when running, it is very suitable for electrical work.

There are already in operation in various parts of the world central electric stations driven by Diesel engines, in which hundreds of h.p. are employed with the greatest success. We illustrate one of these stations, that at Kief (or Kiew), Russia, where four engines of 400h.p. each are installed, the engines being direct coupled to the dynamos and the current employed for electric lighting and tramway purposes. The largest oleo-electric traction station in England is that of the Yardley Station of the Birmingham and Midland Tramways Company, where four 160h.p. (100kw.) sets are at work. On these small sets the fuel cost is only .18d. per unit, and the total works costs, including fuel, labour, stores, repairs, and maintenance .43d. per unit. These figures are the average over a month's run at all sorts of loads, and the results, we believe, constitute a record for any plant of the size in this or any other country.

Although the number and sizes of units in a station should bear some reasonable ratio to the maximum and minimum outputs, it is less important where Diesel engines are used to consider this point so carefully as, for instance, with a steam driven plant. The reason for this lies in the fact that from full load to half load the Diesel varies little in cost of running per b.h.p. Practice shows (as at Birmingham) that whatever the load on the engine may be, a figure may safely be given to cover the cost per h.p. hour under all conditions.

Among the internal combustion engines on whose perfection and constructive improvement great advances have been made in recent years, the Diesel engine deserves special notice as it realises a principle by which a great many cheap liquid fuels become available for motive power which were formerly unfit on account of the difficulty of obtaining complete combustion. The fuel used may be crude petroleum, residues, &c., which can readily be obtained at very low prices. Owing to this and the new principle, by means of which the utilisation of the calorific value of the fuel reaches a degree hitherto unattained, the Diesel engine is the most economical existing engine. Texas, Pennsylvania, Roumania, Borneo, and other fields are at the present time distributing their oil in bulk over nearly every part of the civilised world.

In India, Australia, and other remote quarters, there is now no difficulty in obtaining a supply of oil at prices to compare favourably with those of the English market where oil can at present be obtained in almost any port at 40s. a ton, or only 2d. per gallon. The weight of a gallon is on the average about 9½ pounds, so that this two pennyworth of oil is capable of producing 20-22b.h.p. hours when used with the Diesel engine according to the size of the engine on which it is used.

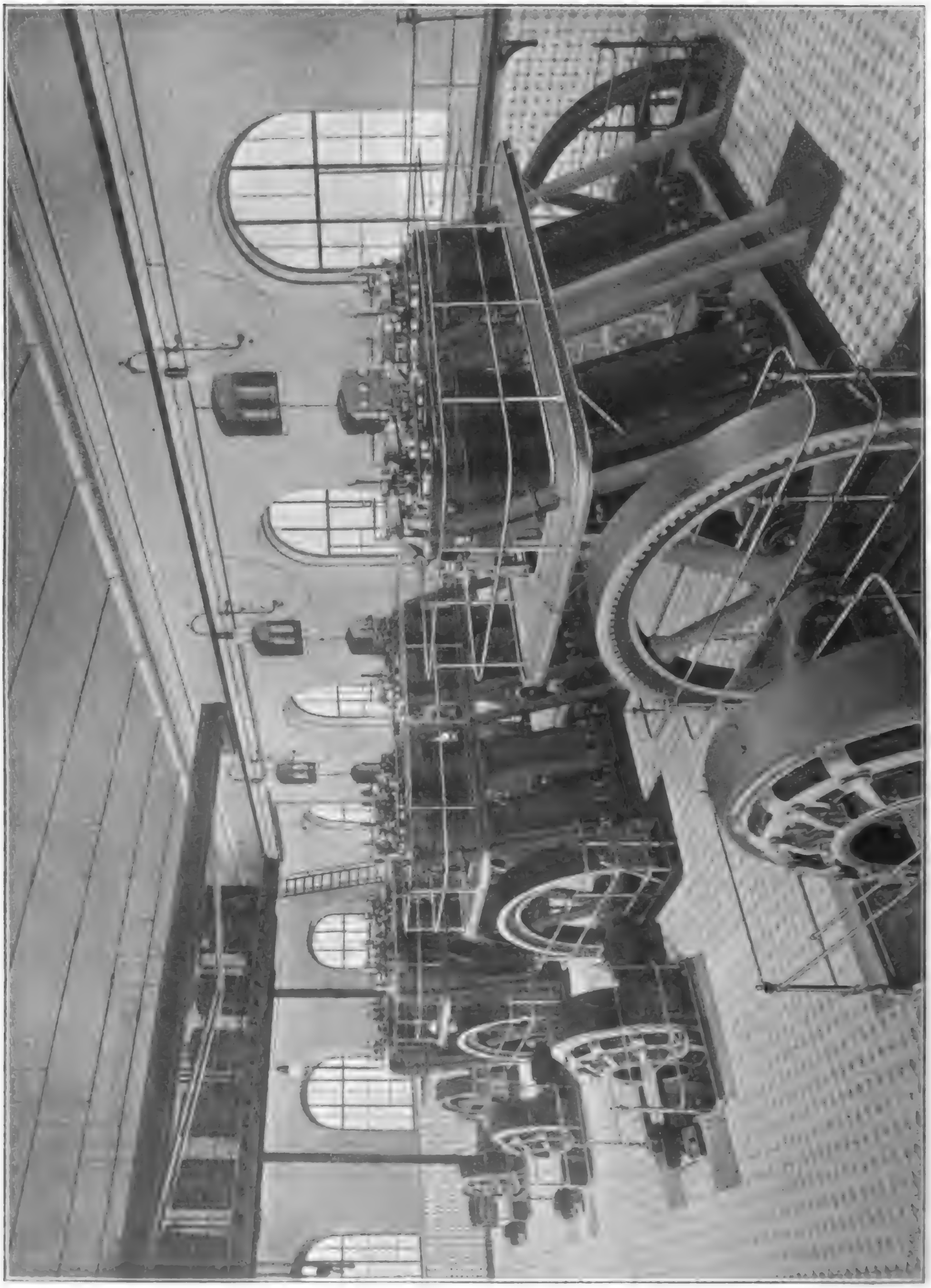
The Diesel engine is of the vertical type and works on the following cycle :

First stroke air taken in alone at atmospheric pressure and temperature

Second stroke compresses the air to a high pressure and to a temperature of about 1,000° F.

Third stroke is the working stroke, during which the introduction of fuel, combustion and expansion take place.

Fourth stroke exhausts the gases.



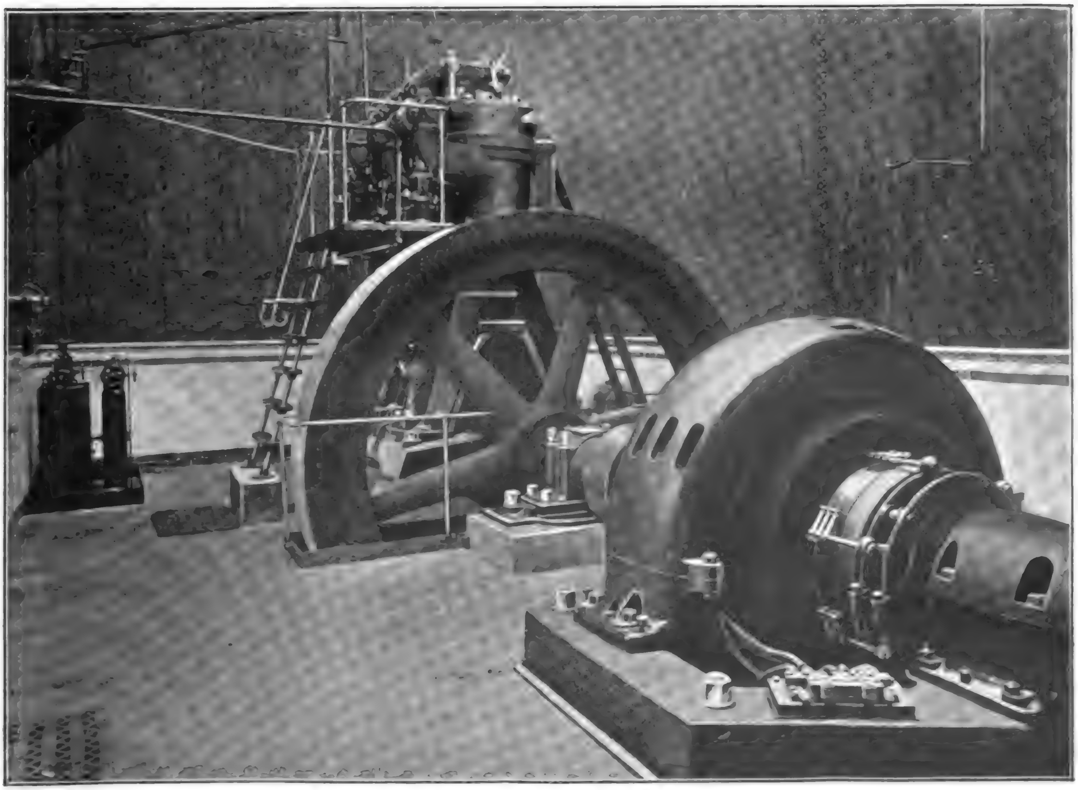
Kief (Russia) Electric Power Station containing Four 400h.p. Diesel Engines direct connected to Generators.

It may be of the one, two, three, or four cylinder type.

Although the Diesel engines are in use for many purposes, there is perhaps one field in which they particularly excel, *viz.*, driving electric generators. It is well known that all internal combustion engines now on the market must be started against very little load. For this reason it is usual to introduce some kind of friction clutch between the engine and the machinery to be driven. With the Diesel, which starts on its own compressed air, contained in steel reservoirs continually charged by the engine, it would be possible to provide sufficient capacity to start against a part of the load. In fact, in pumping stations this is often done.

In cases, however, of electric machinery no clutch is required as it is only necessary not to close the circuit, or not to put the load on the generator or motor until the engine has attained its full speed. As this only requires about one minute, these engines are particularly suitable for use for emergency loads in all electric stations.

The Diesel Engine Company, Ltd., are exhibiting at the forthcoming Electrical Exhibition at Olympia a 20b.h.p. Diesel engine direct coupled to a dynamo, this being the first occasion on which such a plant has ever been exhibited in this country. We understand that many large tramway schemes are now projected in different parts of the world where these engines are to be employed to drive generators. In some cases from 1,000 to 2,000h.p. will be required, the financial success of the schemes being chiefly assured by the known economy of the engines. We illustrate a typical direct coupled set of 160b.h.p., supplied to the Dudley, Stourbridge, and District Electric Traction Company. As will be seen an exceedingly compact generating set is the result of direct coupling.



160B.H.P. DIESEL ENGINE DIRECT COUPLED TO DYNAMO.
(Supplied to the Dudley, Stourbridge, and District Electric Traction Co., Ltd.).

THE HORNSBY ELECTRIC LIGHTING OIL ENGINE.

"THIS 1905 type of Hornsby oil engine marks another stage in advance, both as regards simplicity of parts, steadiness of running, reliability, and marked economy in oil consumption." The foregoing is the concluding paragraph of Professor Robinson's report on the trials arranged by him in February last. The economy of oil consumption amounts to about 15 per cent., or 0.62 pints per b.h.p. with Russoline oil, sp. gr. 0.825 at 60° F. Professor Robinson says that "the explosions at full load were so uniform that the indicator diagrams were all the same."

Over 10,000 of these engines have been sold, and several thousands of the electric lighting type are working in the country houses of the United Kingdom and the Government and public offices in the Colonies and dependencies. The recently-published *edition de luxe* booklet, "Light and Power in the Country House," gives illustrations of over fifty houses and installations where this engine is running dynamos for lighting, heating, ventilating, pumping, stable, dairy, laundry, and other work pertaining to a country house. The engine has gained its splendid position partly by virtue of the unique principle upon which it works, this rendering the engine so absolutely safe and simple that no skilled labour is required, and there are no complicated or dangerous apparatus connected with the maintenance of the heat of combustion, no damp or sparking arrangement being used. But the reputation of the engine is due also to the good material and workmanship of the parts. The engine is durable and strong to do its work, and the makers have refused to weaken their parts for the sake of lightness. This type of engine is specially designed up to 160b.h.p. for electric lighting with a single heavy flywheel and extra outer bearing. The flywheel of the largest engine of this type weighs fourteen tons. This is a truly magnificent engine of such steadiness that for direct lighting there is no perceptible flicker in the light. The installation at Floors Castle (Duke of Roxburghe) of two of these engines of 50b.h.p. each is a typical installation of a large country house plant.

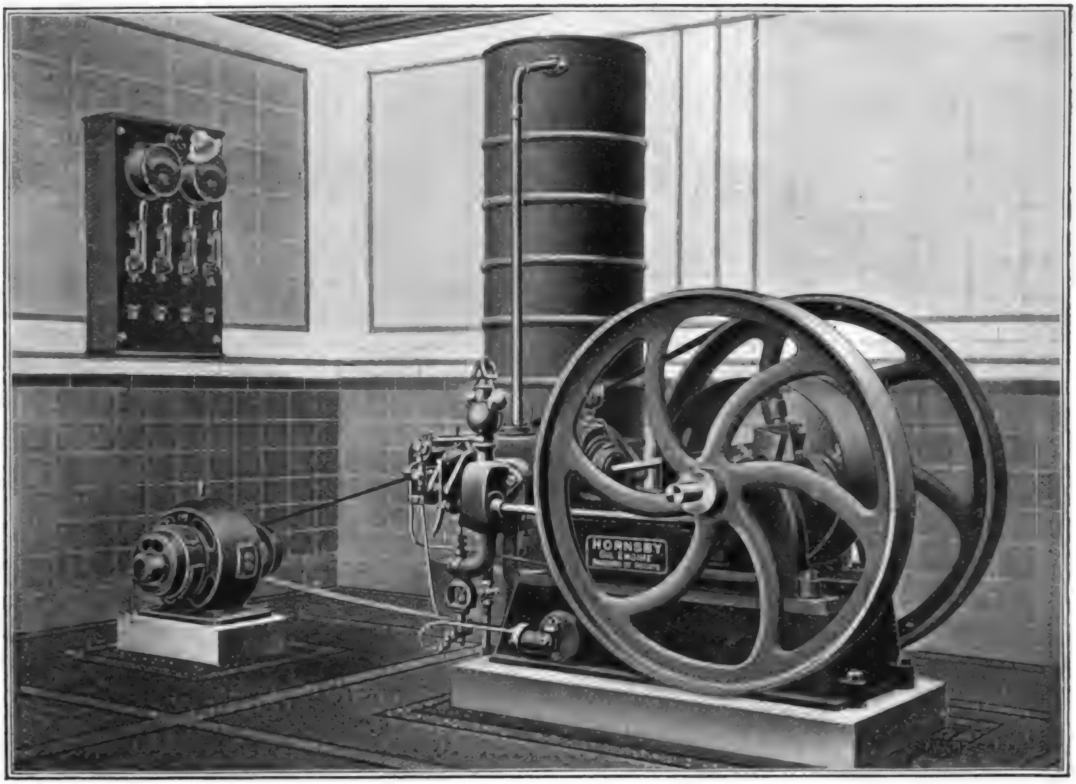
A typical small plant is shown suitable for a country house, and with a 2 to 8b.h.p. engine.

An interesting example of a small portable plant has also been developed at the works. A large number of these engines and dynamos on the same base have been supplied to the Cape Government Railway, and are placed in a truck and conveyed by the through trains, supplying light to the train independently of the locomotive. A similar arrangement on other railways would prevent the after-fires in case of accident.

An interesting application of the oil engine to electric power is made at the new Swale Bridge of the C. & S. E. Railway on the Sheerness line. The bridge is the first railway bridge to be actuated by electricity. It is on the Scherzer rolling lift system with a single balance leaf carrying both railway and road, and is from the designs of Sir Benjamin Baker, K.C.B., and constructed by Sir William Arrol and Co., Ltd. The electrical plant is supplied by Messrs. Dixon, of Glasgow, and the motive power is given by a 9½b.h.p. Hornsby oil engine. The new transporter bridges now in course of erection, one over the Usk at Newport, Mon., and the other over the Suir at Waterford, Ireland, are also worked by Hornsby oil engines.

For country house lighting, to which reference has already been made, the oil engine holds a unique position, and in the matter of economy is unsurpassed. To quote the company's booklet: "The economy of the engine in the matter of fuel rises with the power of the engine. The consumption of oil is approximately .75 pint per b.h.p. per hour (as shown above, the new type shows a reduction in consumption to 0.62 pint), or less than ½d. in cost; and in case of the cheap crude fuel under ¼d. per b.h.p. per hour. Two pennyworth of ordinary petroleum, under favourable conditions, will approximately—

1. Run 40 16c.p. lamps for an hour; or
2. Raise 5,000 gallons of water or sewage 100ft. high;
3. Make ½ to ¾cwt. of ice with refrigerating plant;
4. Maintain 50 to 60 cubic feet at a temperature of 32° F. for 12 hours;
5. Cool 350 gallons of milk 25°;



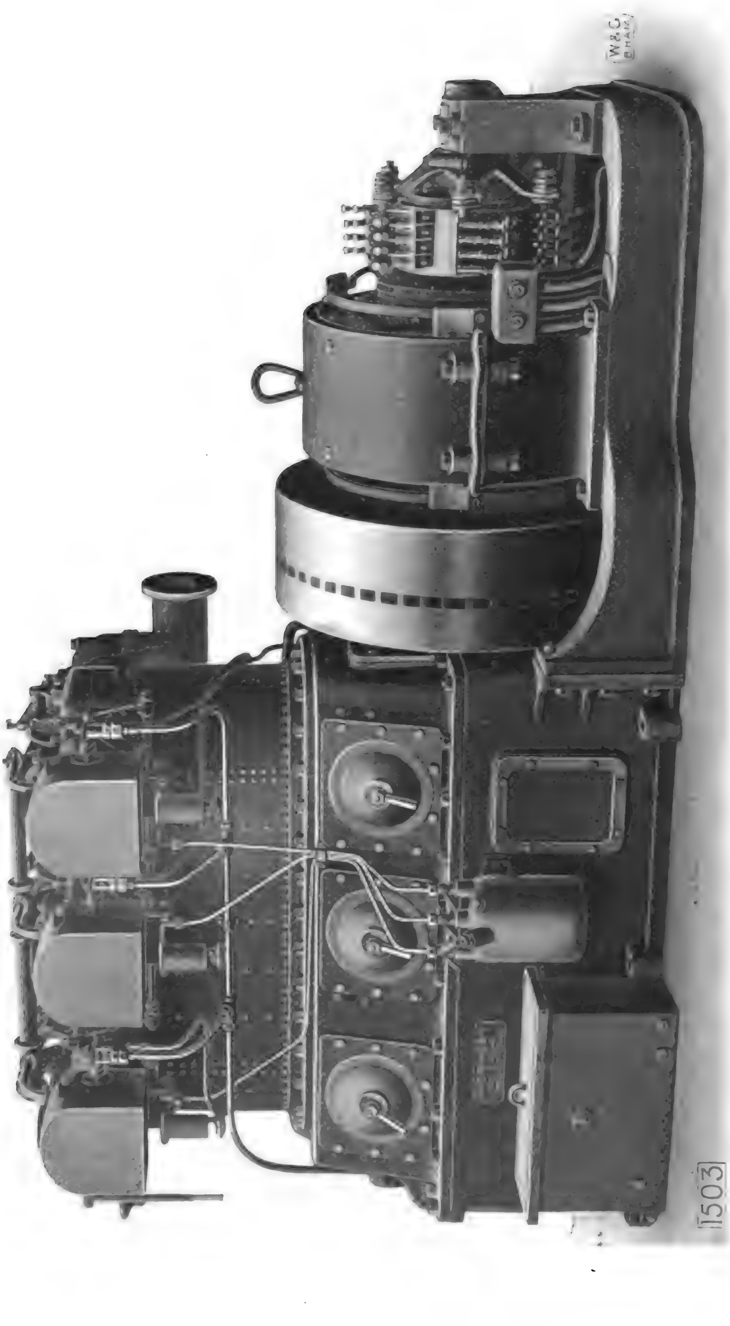
Hornsby Electric Lighting Oil Engine and Dynamo for Country House Installations.

6. Separate 700 gallons of milk;
7. Churn 150 to 200 gallons of cream;
8. Cut 300ft. of 9in. deal;
9. Grind $1\frac{1}{2}$ sacks of corn;
10. Or supply 4 b.h.p. per hour.

(The new type engine gives 6b.h.p. per hour for 2d. worth of oil.)

"With a reliable dynamo of good make driving direct nine or ten 16c.p. lamps may be taken as an approximate calculation per b.h.p.; that is, a $12\frac{1}{2}$b.h.p. engine will give from 110 to 125 16c.p. lamps. An engine with a single extra heavy flywheel and outer bearing is specially made for electric lighting. In driving direct from the dynamo, it is advisable to have heavier flywheels to secure increased steadiness. As the governor in this engine does not allow successive explosions to be missed, as is the case with most gas and many makes of oil engines, there is a greater regularity in the turning moment, and no perceptible variation can be seen in the lights.

"A great boon may be conferred on a small town or village, where there are one or two large users, by increasing the size of the installation somewhat and using the current as a public supply for street and house lighting by night, and for power for the farm or any local industry by day. A new era is thus open for the villages, and either public or private bodies may undertake this work. There are several instances. At Minehead light was needed for the large hotel, and a small local company was formed, and is now supplying the town. The whole cost, including power station, duplicate engines, dynamos, and street mains, has been under £4,000, and there has been a profit from the first. At Uphall and Broxburn, between Edinburgh and Glasgow, a similar installation has been laid down by the local authority. The Fort William town supply is produced by a water turbine with a Hornsby oil engine for supplementary or alternate power. A large installation with five special electric

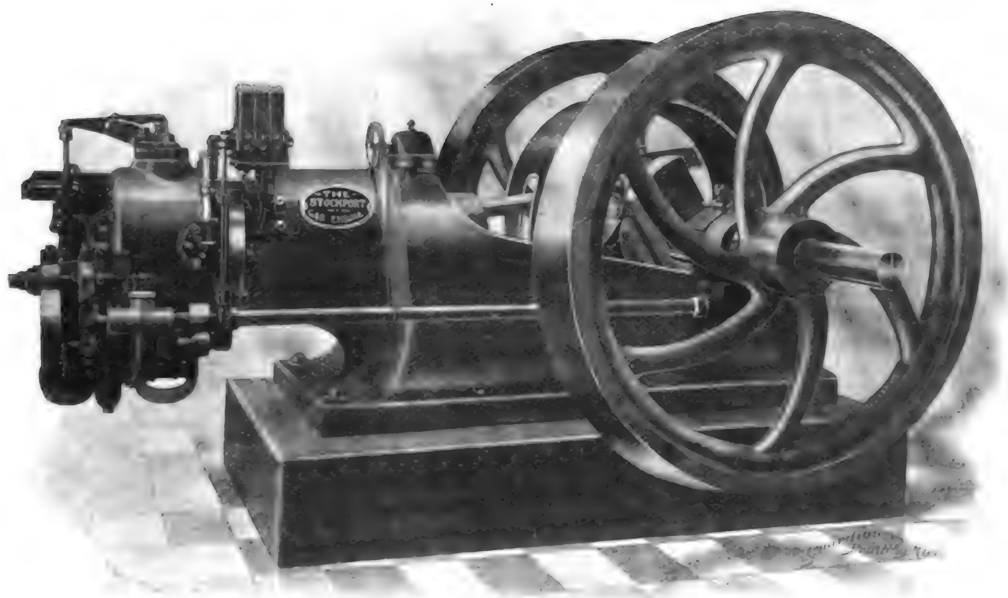


Hornsby Vertical High Speed Oil Engine and Dynamo.

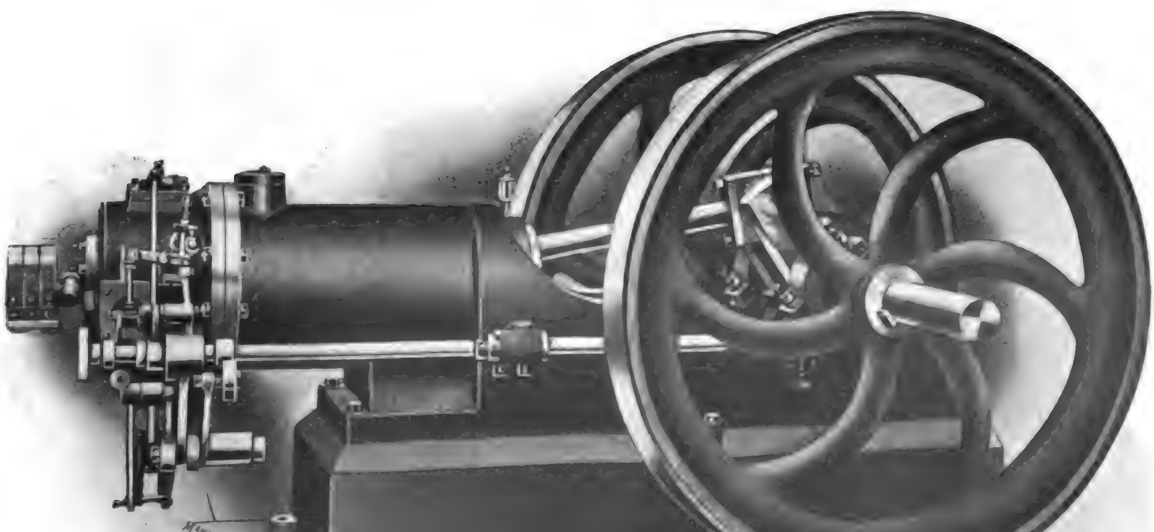
lighting engines has been working for some time in Mansourah, Egypt."

We also illustrate a new type of Hornsby oil engine for dynamo driving. This is actuated on the same principle as the other types, but is built with vertical cylinders and has three arranged over the one crank shaft. The combination with a dynamo results in much economy of space, and sets of this type are coming into extensive use.

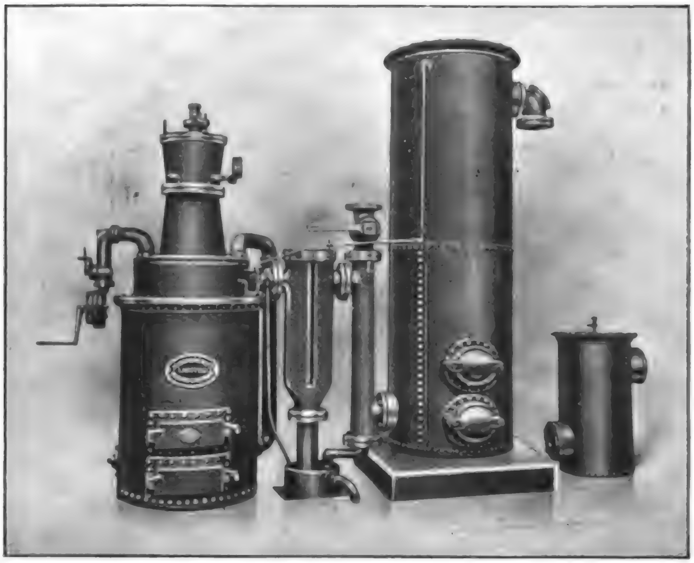
Types of British Gas and Oil Engines.



Stockport Gas Engine by J. E. H. Andrew & Co., Ltd., Reddish, Stockport.



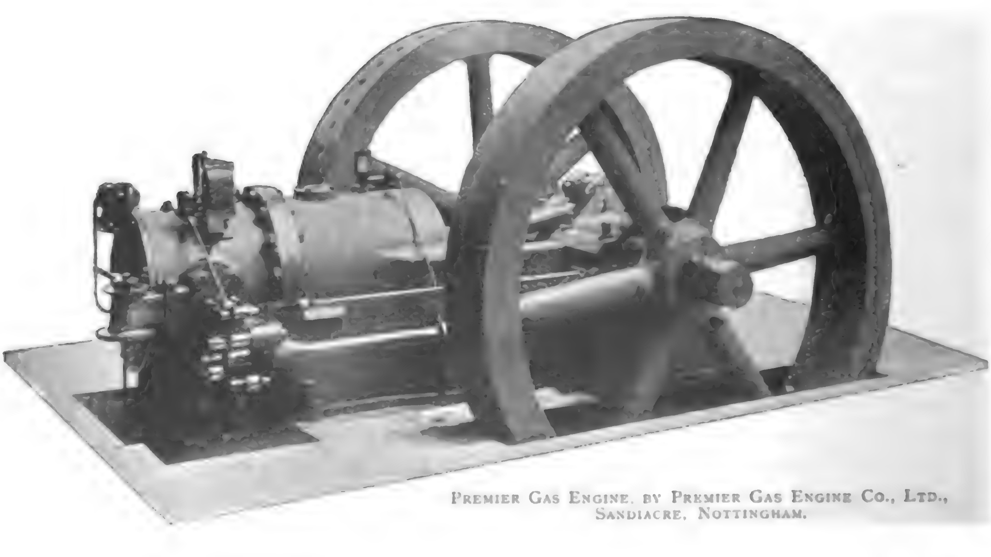
Oil Engine, built by Cundall, Sons & Co., Ltd., Shipley, Yorks.



Types of British Gas Power Plants.

SUCTION GAS PRODUCER, BY J. E. H. ANDREW & CO., LTD., REDDISH, STOCKPORT.

TYPICAL SUCTION GAS PRODUCER, GAS ENGINE, AND DYNAMO, BY CROSSLEY BROTHERS, LTD., OPENSHAW, MANCHESTER.



PREMIER GAS ENGINE, BY PREMIER GAS ENGINE CO., LTD., SANDIACRE, NOTTINGHAM.

The First Great British Electrical Exhibition.
Olympia, 1905.

In its conception, organisation, and consummation the 1905 Electrical Exhibition at Olympia has proved an unprecedented success. The electrical industry has for many years needed the stimulus of a great public demonstration, and from the support accorded by manufacturers to the promoters of the Olympia display, and the generous patronage of the great but uninitiated crowds which passed the barriers, the good intentions of the inaugurators are likely to be very widespread.

A Great Event.—Since the Crystal Palace Exhibition of 1892, nothing on so distinct or gigantic a scale has been attempted, and a comparison between the exhibits of that period—now regarded as dimly historical—and the elaborate productions of our time just exposed in composite array at Olympia, reveals a degree of progress inconceivable at that moment and hardly realisable even at this date. The Olympia Electrical Exhibition is the rejoinder of electricity supply undertakings, in London more particularly, and electrical manufacturers, to the Exhibition held by the gas interest last year at Earl's Court. Visitors to both these shows cannot fail to have been at once struck by the difference in the atmosphere of the two buildings, that at Earl's Court being decidedly detrimental to gas as an illuminant and withal an excellent advertisement to its vitiating properties. Electric lighting carries with it no such self-condemnation, and is, even when used on so large a scale as at Olympia within such narrow limits, nothing but a constant and dazzling eulogy of its own many brilliant merits.

A Public Appeal.—It should be distinctly understood that the Exhibition has been an appeal to that section of the public which uses light, heat, and power to a greater or less degree. Like all other expositions, it was primarily promoted in the public interest, and in just the same manner the influences of its many and varied exhibits will produce practical results in quarters hitherto unsounded by ordinary business methods. We must strongly emphasise the value of these aggregations of commercial concerns, engaged in the wider promotion of the uses of electrical energy, to the average layman, whose knowledge in this sphere is frequently painfully limited.

An Object Lesson.—Events such as the Olympia Electrical Exhibition form permanent object lessons with a business purpose, and are not places of amusement to temporarily tickle public fancy and then pass into the limbo of the forgotten. In this our record of the Exhibition we have endeavoured to lay stress on the advantages of electricity for all the common purposes of lighting, heating, and power. A style has been adopted which will, we hope, make easy reading even to the untechnical, and yet not offend the most particular of our regular and, shall we say, professional readers. As the electrical exhibits at Olympia have made, in one short month, their appeal to prospective consumers of electrical energy, so do we, though in a more lasting manner, put that appeal on record, feeling that the more widely it becomes extended throughout a country now bristling with electricity undertakings the more permanently beneficial will be its results.

A Stable Industry.—Despite the fact that developments in the electrical field have hitherto followed each other in alarmingly rapid succession, the period which will elapse between the 1905 Olympia Electrical Exhibition and its next successor will not be crowded with achievements making naught of established precedent and compelling the abandonment of cherished apparatus. Progress in electrical circles, though rapid, has not disturbed the fundaments upon which a great industry has arisen, and once and for all the notion that electricity supply, as now carried out, is some huge experiment destined to failure may be exploded, and without a qualm. Gas has, beyond doubt, given us the idea of artificial illumination, and all credit is due to it for its efforts to please a fickle public in this respect, but

Photo.] [*Elliott and Fry.*
SIR WILLIAM PREECE, K.C.B., PRESIDENT OF THE OLYMPIA ELECTRICAL EXHIBITION.

THE OPENING.

On September 25th, the Exhibition was opened by London's Lord Mayor, Sir John Pound, who, previous to the brief ceremony, made a tour of the various exhibits. The inaugural luncheon was then held, and in the course of a short toast-list success was drunk to the Exhibition and the electrical industry. Mr. Cunliffe Owen, of the Metropolitan Electric Supply Co., Ltd., Sheriff Sir George Vesey Strong, Lieut.-Col. R. E. B. Crompton, the Mayor of Hammersmith, Mr. W. H. Patchell, Mr. C. S. Northcote, Sheriff Sir George Woodland, and Sir J. Wilson Swan were the principal speakers, and all referred to the many advances made by the electrical industry, and the modern types of apparatus to be seen at Olympia. Col. Crompton made a good fighting speech, defending British enterprise in electrical circles, and emphasising the essential differences, in countries abroad, between the status of the electrical industry and other commercial concerns. We had first taken the matter up and others had followed, but having a free field, and little or no prejudice, developments were more rapidly achieved.

MR. E. CUNLIFFE OWEN, C.M.G., CHAIRMAN EXECUTIVE COMMITTEE, OLYMPIA ELECTRICAL EXHIBITION.

in practice that idea has conclusively exposed its own limitations. That many years must elapse before this fact is generally recognised there could be no doubt, but that it must be realised sooner or later does not, to our thinking, admit of a moment's dispute. The whole question is a matter as to which is the more efficient method of converting the latent energies of coal into light, heat, and power.

Electricity and Gas.—In this country, at any rate, coal is the essential material to each industry, and the result of the rivalry, now growing daily in its intensity, between the two will not remain a matter for conjecture as the struggle proceeds. We have met the competition of the gas interests by straightforward business-getting methods, and it is in this spirit that large and profitable areas are being won over to electric lighting. At no period in the history of either industry has the situation been more keenly recognised, and to the moment of opening the Olympia Electrical Exhibition the "balance of power" may have been said to have rested with our redoubtable opponents. After the boom of the Earl's Court Exhibition this preponderance could not but weigh heavily in favour of gas lighting; but after the brilliance of the Olympian display, with its multifarious opportunities and almost boundless possibilities, the situation of the respective parties must undergo a marked change.

Golden Opinions.—Quite regardless of any opinion held of electric lighting, both in London and the provinces, we unhesitatingly affirm that the Olympia Electrical Exhibition will have done everything to improve that opinion, even among those most bitterly opposed to the best-known artificial illuminant. If the Gas Exhibition did anything to popularise the uses of that commodity for lighting, heating, and power purposes, the Olympia Electrical Exhibition has done infinitely more to encourage the uses of electrical energy in like manner. The Gas Show was obviously an exposition of gas consuming devices designed ***in imitation*** of electric lights and fittings—a doubtful expedient, in fact, which had better have been unresorted to. The electrical display, on the contrary, has had no imitative purpose in view, but has given the strongest evidences of the increasing virility of electricity supply and its capacity for progress without borrowed aid. It must be admitted that the Gas

MR. C. S. NORTHCOTE, M.I.E.E., DEPUTY CHAIRMAN EXECUTIVE COMMITTEE.

Exhibition prompted electrical men to emulation of such means of publicity, and doubtless from the prompt and active response their rivals in turn will be spurred to further public appeals.

Welcome Exhibitions.—Indeed, we welcome this form of open contest, as the competing parties place the option of the verdict in the hands of prospective clients who, after all, must decide the question at issue. A gas exhibition and an electrical exhibition, both held in the same twelve months for a year or two, would bring power and light users of the respective commodities to a sense of their duties, and naturally we feel that the gas consumer would not be long in making up his mind, while the electricity users in their growing numbers would stimulate his decision.

Readers of the following pages must, of course, expect to find them full of eulogies of electrical apparatus for all purposes, but in no case do we feel that there is any overstatement of the facts. The power of discrimination between a good thing and an indifferent one is now highly developed in the British public; consequently, in commending electricity supply material to the notice of the lay reader we have no occasion to lay our praises on "with a trowel." Before referring more specifically to the Exhibition and its organisers we express the hope that in comparing electricity with gas, *for whatever purpose*, the arguments for both be carefully weighed and due allowance made for all the advantages claimed for the one over the other.

THE EXHIBITION.

It is not our intention to bother readers with the *fons et origo* of the Exhibition, so we shall only briefly refer to its organisation. Under the patronage of the Institution of Electrical Engineers and the auspices of the National Electrical Manufacturers' Association, both representative electrical bodies, a powerful executive committee was formed, and we leave our readers to judge of its influential character from the names appended to the portraits of the members which we are able to present with this account. To the assiduous efforts of these gentlemen the success of the Exhibition is primarily due, and so magnificent a result is abundant testimony to their zeal and enterprise on behalf of the project. It will be seen that the interests of both electricity supply authorities, company and municipal, and those of electrical manufacturers are adequately represented on the committee, and we shall not exaggerate when we say that the net result to the parties concerned has been very gratifying. We do not, of course, refer to financial gain from the Exhibition revenue, as a rebate was previously guaranteed to the stand-holders. We refer to the benefits which manufacturer, electricity supplier, and consumer will derive from this exposition of electrical apparatus on so large and comprehensive a scale.

The Organising Managers.

F. W. Bridges.

C. D. Smith.

The Olympia Exhibition was the first Electrical Exhibition and the largest show ever undertaken by Messrs. Bridges and Smith. With the co-operation of a vigorous Executive Committee and zealous Exhibitors, the display was made a complete success.

A Blaze of Light.—The visitor who desired to be impressed with the brilliance of electric lighting when concentrated in a comparatively small area got his wish fulfilled by inspecting

W. H. Patchell, M.I.E.E.
(Chief Engineer Charing Cross and Strand Elec. Supply Corporation).

O. H. Bishop, A.I.E.E.
(Edison and Swan Company).

S. T. Dobson, M.I.E.E.
(Chief Engineer St. James's and Pall Mall Electric Light Company).

W. Davenport
(Sec. Executive Committee).

F. Gill, M.I.E.E.
(National Telephone Company).

H. Oppenheimer
(International Electric Company).

H. W. Butler
(E.P.S. Company).

H. Bevis, M.I.E.E.
(General Electric Company).

W. R. Rawlings
(Nat. Elec. Contractors' Assoc.).

S. W. Baynes, M.I.E.E.
(Electrical Engineer St. Pancras Borough Council).

Portraits of Members of the Executive Committee, Olympia Electrical Exhibition.

Photos. of W. Davenport and S. T. Dobson by Elliott and Fry and Russell and Sons.

G. E. Edgcome, M.I.E.E.
(Electrical Engineer Kingston-on-Thames Borough Council).

Other members were T. C. ELDER (Brush Electrical Engineering Company) J. E. KINGSBURY, M.I.E.E. (Western Electric Company), W. L. PAKENHAM (Crompton and Company), R. S. PORTHEIM, M.I.E.E. (Bruce Peebles).

the stands at night. Then and only then could the varied applications of numerous lamp designs be appropriately evidenced. There was no stint of light, and even the most humble exhibit was treated to an abundance of it. In addition to the permanent installation of arc lamps, which shed their beams over the stalls and aisles, each exhibit seemed bent on outshining its neighbour, and the effect produced quite baffles description. But with all this extravagant radiance the eye models or powerful lights. Such apparatus as switchgear and heavy dynamo electric machinery seemed to excite awe rather than admiration in the average observer; consequently their good points were lost on the great majority. Motors in operation, changing signs, and strange exhibits emitting either stranger sounds or smells attracted the casual visitor, and both the cautious and unwary who paid for admission gave every sign of having their money's worth.

Photo.] [*Howard and Jones.*

GENERAL VIEW OF THE OLYMPIA ELECTRICAL EXHIBITION BY DAY.

seemed never to tire of inspecting apparatus thus flooded with light. It were, of course, foolish to fix the gaze on a strong centre of illumination such as an arc lamp, and provided this almost natural tendency was avoided optical fatigue did not result from a night visit to the Exhibition.

Public Interests.—Considerable attention was attracted by the lamp making which was proceeding in two parts of the Exhibition, and crowds were noticed most around working models or powerful lights.

A Great Show.—Regarded from all points the Olympia Exhibition has been a great show, and its immediate success is a good augury for equally as ambitious undertakings of a similar kind. It has clearly proved that the combined energies of manufacturer and station engineer can bring public ideas into conformity with that progressive spirit of the age which is embodied in their efforts, and which makes for the advance of civilisation into cleaner and healthier spheres. Something

like 120,000 people had passed the turnstiles at the time of writing, and a constant interest in the exhibits was maintained. Little complaint could be made of lack of attraction, as in addition to the stands themselves, there were lectures and cookery demonstrations, for which no charge was made. The Exhibition was, in fact, made as much of an education for the layman as possible, and on this score no effort was spared to keep up the novel side of the show.

the preponderating British element among the exhibitors.

The largest manufacturing concerns in this country, for reasons best known to themselves, withheld their support, but this fact was no deterrent to equally as reputable houses, who made an effective and extensive display. Indeed, it is something of a triumph that the comparatively smaller fry of electrical manufacturers should, by their united co-operation, make up an exhibition in which

Photo.] [Howard and Jones.
General View of the Olympia Electrical Exhibition by Night.

THE EXHIBITS.

The one outstanding feature of the Exhibition has undoubtedly been the "militantly British" character of the firms displaying their products. While we like to honour our neighbours engaged in this great field, we are perhaps jealous of our own in a show promoted by and in the interests of Britain's electrical industry. Consequently, it was with mixed feelings of pleasure and surprise that we noted every branch of the industry was so well represented. Had what may be termed the "great companies" come in, the entire building would have been filled, and the vacant gaps in the gallery avoided; but in remaining aloof, it must with justice to the other exhibitors be said they have in no way detracted from the success of the Exhibition. We do not, of course, infer that they wished it other than success, but the fact remains that without their patronage it has done wonders.

Photo.] [Howard and Jones.

Our Exhibit at Olympia.

The Exhibits at the Olympia Electrical Exhibition.

Lamps and Lighting.

UNDER no better circumstances than those afforded by a great exhibition can the public come to a full knowledge of the value of electricity for lighting purposes. A wider circle is appealed to by the simple incandescent lamp than by all the other products of electrical manufacture ; consequently the average man finds his attention focused on this simple contrivance. The Ediswan and Robertson lamps, now both extensively used were to be seen in process of manufacture at the Exhibition, and the stands of the respective firms were always conspicuous by large crowds around them. Like everything else, the success of the incandescent electric lamp is all in the making, and observers of its manufacture could at least testify to the thorough manner in which each process was carried out. The business has now been developed to a degree bordering on perfection, and good cheap lamps are now on the market of entirely British manufacture. Users of electric lamps should take note of the reputable British brands, and do their utmost to obtain them before patronising goods imported from abroad.

Lamp Types.—Of the lamps exhibited at Olympia there were specimens of every type, and they may be mainly classed under two headings :

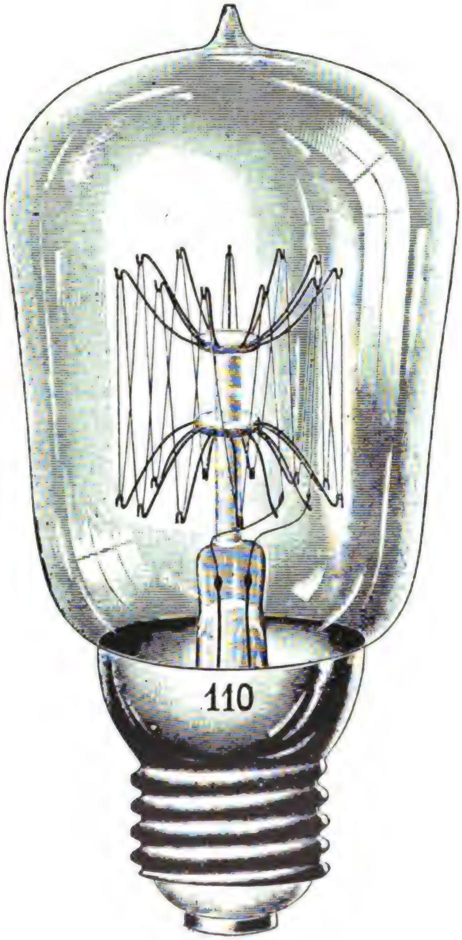
i. Arc lamps.
ii. Incandescent lamps.

The first named are constructed for both open and closed burning, and exist in almost every conceivable form. A recent development is the flame lamp, now becoming a common sight with its golden rays in streets and open spaces ; lamps of this class are also suitable for the lighting of shops and extensive interiors. It may not be well known, but the electric arc lamp is the most economical form of illuminant extant, and it possesses a feature quite unique in lamps—its illumination remains constant no matter how long it is kept burning: of course, like no other electric lamp its burning elements need renewal at frequent intervals, but this makes no difference to the *constancy* of the light emitted.

Incandescent lamps are chiefly used in the simple carbon filament form, and as now made by improved processes are highly efficient. At the Exhibition numerous modifications of the original lamp separately but contemporaneously produced by Edison and Swan were on view and to these we shall refer later. In its bulb form the incandescent lamp is a perfectly safe illuminant, and its applications to the art of lighting are only limited by the pocket of the purchaser. Despite its twenty-five years' use the limits of its adaptability have yet to be reached, and while it can be employed in conjunction with the most elaborate and artistic fittings, it is equally applicable and appropriate to the unadorned pendant.

The Nernst Lamp.—There was no distinct exhibit of Nernst lamps at the Exhibition, but their important position in ordinary electric lighting to-day merits some reference being made to them. In its simplest form, the lamp can be inserted in an ordinary bayonet socket holder, and this pattern has become very popular. A total saving of about 60 per cent. in current is claimed, but this amount is reduced by renewals of burners to about 30 per cent. It has the advantage of a constant current consumption through its life, though the efficiency falls considerably after about 500 hours burning. With the smallest form the makers estimate to save about 16s. per 1,000 hours over three 16c.-p. glow lamps, excluding renewals, and with energy at 3½d. per unit. Despite the use of a resistance and a cut-out, which at first sight appear complicated, the lamps are being very widely used, and no better testimony to their efficiency need be cited.

TYPE B
NERNST LAMP FOR ORDINARY LAMP-HOLDER.
(Electrical Company.)
This lamp gives about 50 candle-power light, and consumes energy equivalent to that needed for three 16 candle-power lamps.



THE TANTALUM LAMP.

(Gives 25 candle-power light for a current consumption of 45 watts.)

Tantalum Lamps.—Quite the latest practicable form of incandescent lamp is that known as the "tantalum." Like the usual carbon filament it is rendered incandescent in a vacuum, while its efficiency is almost double. It will be seen from the illustration that a very long filament is used, this being stretched round special supports attached to a central glass rod. This method of supporting admits of the lamp being burned in any position. At present it is only made for voltages up to 125, and the economical life is put by the maker at about 500 hours. The 120 volt types give 25 candle-power for an energy consumption of 45 watts, and the light emitted is whiter and more pleasing than that of the carbon filament lamp. An exhibition of these lamps was made by SIEMENS BROS. AND CO., LTD., DRAKE AND GORHAM, LTD., and others. At present the lamps are sold for 4s., but as the method of manufacture improves and the demand increases this figure will doubtless be materially reduced.

The Osmi Lamp.—Another distinct novelty in the way of incandescent lamps was the Osmi lamp, exhibited by the GENERAL ELECTRIC CO., LTD. The efficiency of this lamp is about equal to that of the Nernst, but as it cannot be commercially produced for so low a pressure as 100 volts, special adapters for burning lamps in series are at present necessary. Another peculiarity of the lamp is that it can only be burned in a vertical position. At the present price of 7s. 6d. each these lamps are not at the moment commercially competitive with the ordinary types, but they should certainly be improved before long.

A Push Switch at Last.—A new push switch was shown by MESSRS. EDISON AND SWAN which practically solves an old and tiresome problem. Electricity is always associated with buttons, and users of electric light like buttons to press when turning lights on or off. Hitherto two buttons have been used and a bulky switch resulted, but the Ediswan push switch quite obviates this expedient. It

THE OSMI LAMP. (General Electric Company.)

A new lamp which must be burned in series with others similar. Three are so run on 100 volt circuits and five on 220 volts. The filament is insusceptible to wide voltage variation.

A Single Plunger Push Switch.
(Ediswan.)

comprises a plunger, having a vertical movement and a swing block of porcelain, the latter being pivoted on a toggle, which is thrown from side to side by the plunger. A loose spring button moving in a guide serves to actuate the porcelain and puts the lamps in or out of circuit. The illustration herewith shows how neatly the idea has been put into practice. Types having removable keys are also made, and any finish is obtainable from the most simple to the ornate.

Radiolite Lamps. — This lamp, which is also an Ediswan product, is adaptable to any ordinary circuit, and is recommended for its efficiency and pleasing light. It will fit an ordinary lamp-holder, and with its special reflector distributes the rays in a more useful manner than does the ordinary lamp. Lamps of this class are a welcome addition to the list of incandescents, as they give the public a better range of illuminants from which to choose.

The Radiolite Lamp.
(Ediswan.)
For the same current as an ordinary 16c.-p. lamp this gives 25 to 30c.-p. Shadows are also toned down.

They are becoming very popular, and since their introduction some twelve months ago, have been made in constantly increasing numbers.

Artistic Lighting.—In the central or reception room of the Ediswan exhibit was a large and varied collection of beautiful fittings from which both wealthy and middle-class buyers could select without fear of disappointment. Artistic electric lighting is somewhat costly, but when

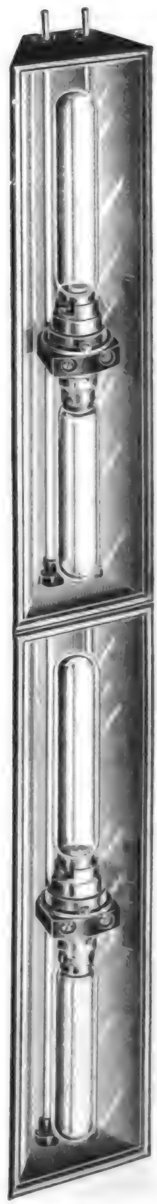
Art Metal Fittings for Two Electric Candle Lights. (Ediswan.)

thoughtfully chosen, good fittings remain a constant charm. Where doubt exists as to what will well suit a particular case, it is always better to be guided by the maker, whose experience will generally temper his advice with good judgment.

ELABORATE STATUETTE BEARING ELECTRIC LAMP WITH FLAME GLOBE. (Ediswan.)
A figure for staircase and hall use.

Shop Window Lighting.—The electric lamp is more readily adaptable to shop window lighting than any other illuminant. There is no need to sound its praises, as they have already been voiced in the field of practice. The GENERAL ELECTRIC CO., LTD., who exploit the Robertson lamp, included in their well - selected exhibit a special reflector for shop window and display lighting. It was appropriately applied for illuminating the name fascia of the stand, and being concealed behind the cornice was not visible to the naked eye, and cast no rays into the eyes of the observer. The fitting is known as the M.I.P. (*multum in parvo*), and is arranged in 12in. units which can be made to suit any conceivable requirement. Devices of this kind enhance the value of electric lighting to tradesmen, who have to consider illumination from the point of maximum distribution with minimum discomfort to the shop gazer and prospective customer.

The Angold Arc.—On the same stand was to be seen the G. E. C. Angold arc lamp, developed specially for interior and shop window lighting. Without burdening the reader with constructional details, we may say that this lamp has come into extensive use, chiefly on account of its extreme simplicity. Arc lamps are often associated by the uninitiated with complex mechanisms liable to get out of order at short notice. The fact that lamps of this pattern are giving satisfactory results in the hands of drapers, grocers, and other non-technical tradesmen testifies to their reliability and suitability even with the inexperienced. The Angold arc lamp is also made in the flame type, and this pattern is proving



A NEAT REFLECTOR, WITH ELONGATED LAMPS FOR SHOP WINDOWS.
(G. E. C.)

ANGOLD ARC LAMP. (G. E. C.)

equally successful for shop window lighting. In conjunction with them were also shown the necessary accessories, such as winch gear, resistance coils, and cut-outs.

Records in Arc Lamps.—As might have been expected, arc lamps were very generously distributed about the building at Olympia. In fact, they seemed to be everywhere when darkness came on, and they were put into circuit. The UNION ELECTRIC CO., LTD., who are arc lamp specialists, had three distinct exhibits of their lamps. One of these comprised the lighting of the exterior of the Exhibition, the main approach, and the roof. For this purpose the Union Excello lamp was used, and circuits of four in series of 220 volts were run, thus giving 46 volts per lamp and a current of 12amps. for the circuit. Lamps of this pattern give 3,300 mean hemispherical candle-power, and burn for eighteen hours each. The second exhibit comprised a large number of lamps dotted about on the various exhibitors' stands. The third display was at the company's large stand, where almost every pattern of their arc lamps could be inspected. We specially noticed a differential pattern of lamp widely used by printers and other trades requiring shadowless illumination. In this pattern lamp the light is reflected to the ceiling, and thrown back to the room, the reflected rays being quite shadowless. We understand that in a large London printing establishment 100 lamps of this pattern are used in one room.

Photo-Process Lamps.—Photographers and engravers have now found the arc lamp an indispensable adjunct to their business, and photographers especially should introduce it where daylight alone is resorted to. The Union Electric Company exhibited a special electric lamp for blue printing and process work, the arc being of the enclosed type. It has been proved in practice superior to the ordinary open arc, and in addition to simplifying the handling it is more economical of current. It also burns for a longer period without renewing the carbons.

Twin Arc Lamps.—Lamps burning two arcs in series within a single globe have come into extended use lately, and the Union Electric Company have a design embracing novel features. The lamps will, of course, burn in simple parallel on 220 volt circuits, and each arc has an independent regulating device which ensures an even voltage at each arc and conduces to steady running.

Among other Union Electric lamps we may mention their Coltru lamp, for selecting and comparing colours, and a line of miniature arcs which are of immense value as competitors to

EXHIBIT OF THE UNION ELECTRIC CO., LTD., LIGHTED BY EXCELLO AND OTHER ARC LAMPS.

incandescent gas lights. With lamps of this pattern the small user can get "more light at less cost" than from gas, and as we have previously indicated the illumination is constant during the burning of the lamp. It does not gradually decrease the longer the lamp is used as is the case with any incandescent lamp. These midget arcs seldom exceed a foot in length and four inches diameter, so that in the matter of dimensions they score.

A Monster Arc.—The Union 25 ampere Excello lamp, for which 20,000 candle-power is claimed, was also on view, but at the company's stand could not be shown lighted. A lamp had, however, been hung above the only Diesel engine in the hall, and the effect was almost startling. Coming round a corner of the adjoining stands one might almost imagine something was on fire. With so heavy a current a great increase in brilliance was to be expected, and with the flame carbons employed the golden light was very effective. Such a lamp should come into extensive use for large halls and open public spaces.

The Stewart Lamp.—At the stand of the ELECTRIC AND ORDNANCE ACCESSORIES CO., LTD., an extensive display was made with the Stewart enclosed arc lamps. The makers have, with commendable determination, decided that the enclosed arc is the lamp of the future, and in recommending this type for adoption point to the United States of America, where the open arc is falling into disuse. Whether the enclosed arc lamp will soon supplant its older rival in this country we cannot say, but the fact remains that to the user of arcs for shop lighting and display purposes the enclosed lamp has many advantages. The best angle of illumination of this type of lamp is much nearer the horizontal than with the open arc; consequently the lamp can be placed much closer to the ground. With enclosed lamps, such as that to which we have referred above, the life is greatly extended as the cost of maintenance (in carbons, trimming, &c.) is reduced below one-tenth of that of the open arc. The Stewart lamp, which is of British manufacture throughout, is made with all parts interchangeable. The inner bulb is sealed automatically, and no skill

STEWART ENCLOSED ARC LAMP.

DISPLAY OF ARC LAMPS AND MOTORS MADE BY THE ELECTRIC AND ORDNANCE ACCESSORIES CO., LTD.

on the part of the trimmer is required. It is made in a special form for photographic purposes, and burns singly on circuits of 100 to 250 volts. A twin carbon lamp is another speciality, two arcs burning in series in a single enclosure globe.

Statuette Lighting.—It is no matter for wonder that well-to-do folk prefer electric lighting to gas. With the latter they are denied many an adaptation of light to some charming figure or piece of sculpture, because the gas burner does not admit of the right kind of lighting necessary to the subject. The gas flame must be kept clear of the metal or other substance of which the design is composed, and even if it is adapted a clumsy result is obtained to allow of the necessary clearances. Tiny electric lamps can, however, be made to fill the smallest niches and to give pleasing effects with figure poses and attitudes quite impossible by any other illuminant. MESSRS. FALK, STADELMANN, in addition to having a

TYPICAL FIGURE IN ART METAL WORK.
(Falk, Stadelmann.)

HANDSOME ELECTRICALLY-LIGHTED STATUETTE.
(Falk, Stadelmann.)

wide range of designs in electric light fittings, exhibited some magnificent types of statuettes adapted for electric lighting. It would be quite impossible in the space at our disposal to describe fully the many beautiful examples of this class of fitting manufactured by the firm. We can, however, give illustrations of fine models depicting the style of work done.

Art Figures.—The use of artistic figures for electric lighting is evidently on the increase, and should certainly be encouraged. For the illumination of a hall nothing more ugly and inappropriate can be conceived than a pendant such as is frequently used with gas. An incandescent gas mantle in a hall is little short of sacrilegious, and is to be deplored in the houses of the artistically minded. For hall, staircase, and landing lights the statuette is the ideal support for the lamp, and as but a glimmer is required, not a flood of light, the desired effect can be better obtained. A good metal figure is not very costly, and when wisely selected never looks out of place. With a comprehensive stock such as is kept by Falk, Stadelmann and Company, there need be no difficulty in making a choice, and we can vouch for satisfaction in the result. In special cases, mantelpiece figures are quite in keeping with the decorations of the room, and can be procured to

bear lights sufficiently powerful to read by when one is seated at the fire. When expense is little or no object, electric lighting should always be carried through on artistic lines, and if a reputable house dealing in high-class fittings is patronised, a wholly satisfactory installation will result. There is really only one limit to the adaptability of electric lighting for the purpose mentioned, and that is the cost. Where this can be borne ideas can be elaborated, and designs incorporated into the lighting of the house quite impossible with such luminants as gas and oil.

Artistic Fittings.—The visitor could not fail to be impressed by the imposing exhibit of VERITY'S, LTD., which gave particular prominence to all that is best in the way of artistic fittings. We may remind our readers that Messrs. Verity have made fittings since the days when such things were first needed, and they claim to have set the fashion both in oil and gas and electrical designs. In the latter field they have, however, eclipsed their efforts with gas and oil. We were able to inspect some really lovely things for pendant, bracket, and table use, and there seemed to be little or no reason for complaint, even by the most fastidious. At the present time artistic pendants appear to be greatly in demand, and some neat ideas have been worked out in this particular. In some cases a number of lamps will depend from a single point, but each will hang at a given position and have its own shade or tassel. In others the lamps will be placed around a wide ring and hang with a shade, which gives a pleasing soft effect to the light emitted. We understand that quite a number of these are sold for use in flats.

Theatre Lighting.—Among the designs shown on Verity's stall were two richly-carved and worked brass brackets, made for the New Comedy and Waldorf Theatres. The designs are for two and three light brackets respectively, and illustrate what handsome ornaments good fittings can become. For such a purpose naturally the best is required, and only trained and skilled workmen are able to produce work to the required standard.

Uniformity in Design.—We noticed especially that Messrs. Verity's have a line of fittings in which a particular pattern (such as a panel, an oval, &c.) is carried throughout the series. The design will be found on the ring of a shade, on the back of a bracket, the arms of an electrolier, the standard of a table lamp, and so forth, and a very pleasing effect is produced by the various modifications and adaptations of the patterns. In many cases this uniformity is a recommendation to customers, and it is quite possible to incorporate any particular design into a series of fittings specially ordered. The many ways in which electric lamps can be used adds interest to this method of including some fantastic shape into the form of each different style of lamp employed. At first sight this may seem a diversion only for the rich, but in the same way that furniture of good quality, but of undoubted artistic merit, can be reasonably obtained, so also can work be done on electric light fittings which will raise them above the level of the commonplace and stamp them, say, with some distinguishing family mark. There needs but to be a demand and the supply will arise to meet it for special work of this nature. Whether Verity's, Ltd., have a monopoly of the notion we cannot say, but interested householders should certainly inspect this line of theirs.

ELABORATE PENDANT FOR SIX INCANDESCENT LIGHTS.
(Verity's, Ltd.)

Outside Fittings.—It is sometimes urged that electric lamps give trouble when erected in exposed situations. In the early days there certainly was cause for complaint on this score; but like everything else electrical, outside

fittings are now the product of specialists who have studied the needs of each particular case. The REASON MANUFACTURING CO., LTD., in their exhibit, exposed to view patterns of lanterns and other designs to contain lamps for outside lighting. This company has done much work in the way of street lighting with incandescent lamps; consequently their standard types will be found serviceable for use in all exposed situations. The dark spots around a works or building need never go unlighted for want of a reliable fixture which will stand up to the weather.

Twin Carbon Lamps.—On the same stand a number of interesting arc lamps were to be inspected. They represented quite the latest ideas in arc lamp control, in that the shunt coil, usually regarded as inseparable from such mechanism, is entirely dispensed with. What is known as a limit switch is fitted which ensures a constant length and voltage for each arc. Any device which simplifies arc lamp construction should always be welcome to the user of electric lamps, as he is more likely to understand their operation, and thereby become strengthened in his determination to use such lamps more extensively. In this respect an enthusiastic consumer will do much good in a district by recommending such and such a make lamp to those who contemplate following his example. We understand that the Reason Manufacturing Company also make miniature arc lamps fitted with similar mechanism, and these should have a very considerable vogue, as they fill a distinct gap between the Nernst type lamp and the more powerful arc.

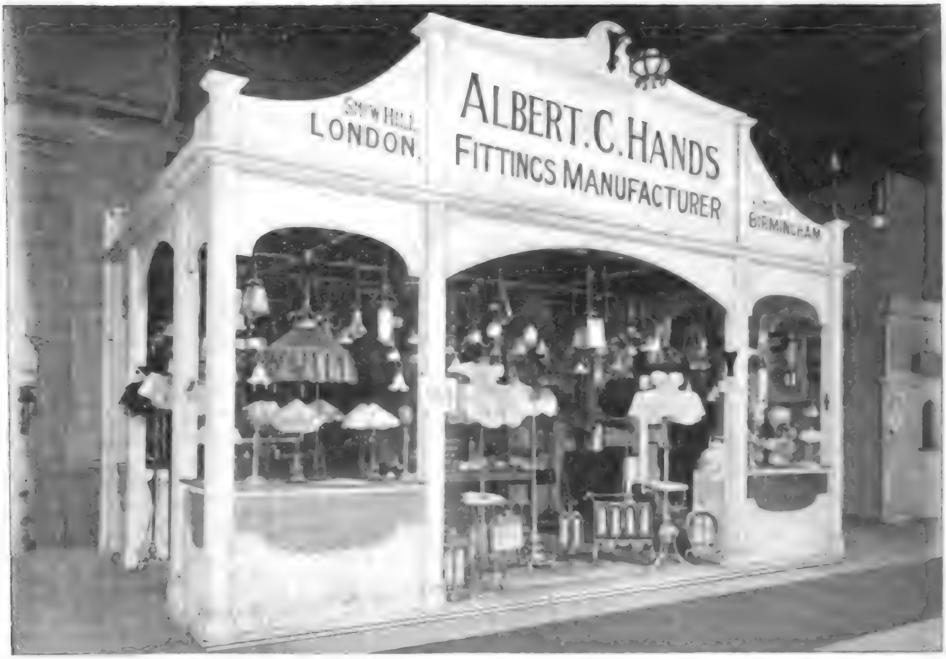
A British Carbon.—While on the subject of arc lamps, we cannot but mention that the GENERAL ELECTRIC COMPANY occupies a unique position as the only makers of arc lamp carbons in this country. The majority of the carbons consumed by British arc lamp users are imported, but since the Witton carbon works were opened a large share of the business has been done by them. We would remind those who do not burn the Witton carbons that they are neglecting to support home industries, whether knowingly or not; and when as good an article can be obtained in this country the employers of home labour may with equal benefit be supported.

Robertson Lamps.—The name Robertson is regarded as synonymous with best in incandescent electric lamps, and many years' experience has contributed towards the production of an almost perfect article. Under the shadow of the General Electric Company's exhibit was a large open space reserved for practical demonstrations in Robertson lamp-making. At the back of the space a monster sign emblazoned the name on the eyes of visitors, and attracted them in shoals to watch the processes of manufacture. The Robertson lamp seems to have established an essentially British name for itself, and its popularity justifies the makers' claims for its

THREE-LIGHT PENDANT WITH SPECIAL METAL WORK. (G. E. C.)

excellence. Of its manufacture we need not speak in detail, but we may say that by testing methods rigorously enforced at the works, the "wasters" or bad lamps, inevitable with even the best methods, are rejected from the good lamps. Were this practice strictly followed in all lamp factories, more especially abroad, the number of complaints against lamps would be a minimum.

The Wytelite Lamp.—A very pleasing effect in illumination is obtained with the Robertson Wytelite lamp—a lamp having an enlarged bulb and a special reflector. The makers claim increased efficiency and candle-power with these lamps, and their claims seem to be borne out in practice. Though the price is almost double that of the common incandescent lamp, the greater saving and higher candle-power brings the all-round economy above the older form of lamp. This is, of course, not difficult to see, as one Wytelyte, giving 25 candle-power, will displace three lamps of 8 candle-power, and consume half the energy in producing practically equivalent illumination. This effect, when spread over a large room, results in fewer lamps being needed and a reduction in the wiring necessary.



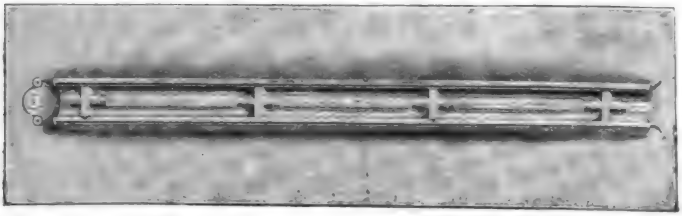
ARTISTIC FITTINGS AS DISPLAYED BY ALBERT C. HANDS AT OLYMPIA.

Tasteful and Artistic.—These two words appropriately describe the exhibit of ALBERT C. HANDS, which was a brilliant display of art metal fittings and radiators. To inspect a stall of this kind is to gain more knowledge of the artistic side of electric lighting than could be imparted by a dozen books or collected in a hundred houses wired for electric light. When the many designs are brought to notice and their points enhanced by the glow of lamps placed in the fittings, the prospective purchaser is not difficult of conviction, nor does he lack for variety from which to select. To describe in detail the wide range of fittings and radiators exhibited by Mr. A. C. Hands would be trespass on valuable space which can best be occupied by the most telling of all descriptive matter, an illustration. We reproduce a view of the exhibit, which is typical of the many designs, and indicates the class of work undertaken by the firm.

Linolite.—Electric lighting at so much a yard might well have been the notice placed on the stand of the LINOLITE COMPANY, for they certainly deal in yards of light. The Linolite lamp is too common an object to need description, but we may remind shopkeepers and tradesmen who have goods to exhibit in shop windows that this method is highly serviceable for the purpose. To illustrate what can be done with the system the company's booth at the Exhibition was surmounted by the word "Linolite," fashioned out of sections of the material. Further testimony to its utility for show purposes was to be found at every turn of the various stands, the rows of lights being frequently met with. Our illustration explains better than words the construction of Linolite, and we need only mention a few of the uses to which they can be placed. For temporary lighting such as is needed on all festive occasions it is, of course, invaluable.

Displayed Lighting.—For display purposes in shops, window cases, picture galleries, &c., it is more readily adaptable and gives a more even distribution than do separately concentrated points of light. The great feature lies in the ease with which the ideal of reflected light for private rooms can be obtained. Such a length of light ensures good distribution, and the effect in the room of rays reflected from the ceiling is decidedly pleasing and much more conducive to comfort. Quite a number of large rooms have been fitted in this way and with complete satisfaction to the customer. We were informed that the current consumption is 1d. per yard per hour where 6d. per Board of Trade unit is charged, so that this figure becomes very moderate with the greatly reduced charges now prevailing throughout the country.

Styles in Fittings.—Despite the mechanical tendencies of a mercenary age, there is a flourishing movement having "Art in the Home" for its object. The busy City man may labour daily in an office unadorned by anything but the utilitarian; but in his domestic abode



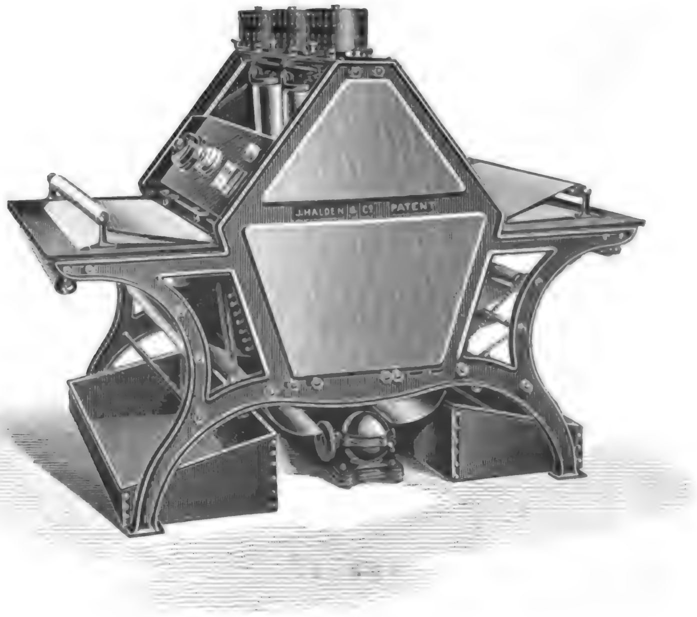
SPECIMEN OF LINOLITE FOR WINDOW DISPLAY ILLUMINATION.

he will only have things in certain styles. He may be a crank for styles, but if he can get what he wants he is satisfied. In the matter of electric light fittings he could obtain designs in the Dutch, Elizabethan, Georgian, and Adam styles, judging by the elaborate display of the LONDON ELECTRICAL FITTINGS CO., LTD. From the collection on their very attractive stand we may select for reference a Wedgwood mounted six-light corona in the Adam style and a lantern of the Elizabethan period. There is a greater satisfaction in adapting the antique to electric lighting than can obtain with gas or oil, as each point can be faithfully reproduced, and the fitting is not damaged in the least by use, as the lamp itself has no action upon it.

Blue Printing by Electricity.—Improved facilities for expediting the despatch of office work have given rise to many useful inventions. The arc light copying frame is one of these, but in its simple vertical cylindrical form it is well known. Messrs. J. HALDEN AND COMPANY exhibited an entirely new form, in which the process of copying is rendered continuous. It is made in both single and double form; and with the latter one set of arc lamps will work on two tracings and print at the same time. A tracing may be any length up to 100yds., or a continuation of tracings lightly joined together can be passed through the machine. A blue line print will satisfactorily traverse the machine at the rate of one to two minutes per lineal foot, and the two 7 ampere lamps will consume 1.4 units on a 100 volt circuit. The machine is driven by a small motor, and can be easily attended by one man.

Outshine Lamps.— At the stand of the SUNBEAM LAMP CO., LTD., a pattern of the new high efficiency incandescent lamps was to be seen. This lamp has a large glass bulb and opal reflector, and fits into an ordinary bayonet socket holder. It is claimed that a softer and more brilliant light is obtained, that there are no sharp shadows, and that current consumption is greatly reduced. Lamps of this pattern are to be strongly recommended to small users of electric light, as they are more efficient and, compared with an ordinary 16c.p. lamp, they consume the same current for a greatly increased light. Another strong point in their favour is, they do not require a special holder, and at a moment's notice can replace the more commonly used lamp.

New Flame Arc Lamps.—The flame arc lamp has made a great hit and it has come to stay. Not only can it be employed for street lighting purposes but for shop front lighting also. The brilliant yellow light emitted by these arcs is now a familiar sight and is their distinguishing feature. Messrs. OLIVER AND COMPANY exhibited a new pattern of flame lamp which they have dubbed the "Oriflamme," and which has the advantage of long burning. The



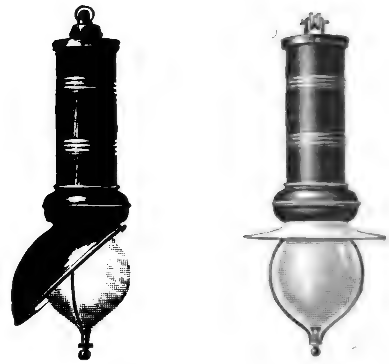
ELECTRIC BLUE PRINTING MACHINE.
(Halden and Company.)
The paper is fed forward by an electro-motor, and several arc lamps furnish the requisite light.

lamp will burn from forty to fifty hours without re-carboning, and the carbons used are consumed to within about 2in. of the end. The lamp is fitted with two magazines and the arc takes place horizontally between the lower ends of the carbons. With the carbons placed above the arc in this manner shadows from vertical rods and a lower carbon are avoided. For the same consumption of energy greater light is claimed for this lamp over either the ordinary flame lamp or one of the open pattern. As each lamp requires a lower voltage across its terminals, a greater number can be burned in series. The light has good penetrating properties and there is no troublesome scintillating effect. The lamps are already extensively used for street lighting.

Records in Arc Lighting.—The city of Cardiff can boast a record number of enclosed arc lamps supplied by one firm—ARC LAMPS, LTD. The lamps are of the twin carbon type, and some 800 in all have been installed. This is a remarkable testimony to the efficiency of the W. J. Davy lamp, and, withal, is clearly indicative of vitality in this branch of electrical manufacture in this country, all these lamps being entirely British made.

THE OLIVER FLAME ARC LAMP.

(The latest in arc lamps.)



MIDGET ARC LAMPS.

(Arc Lamps, Ltd.)

Tiny lamps of this class are very suitable for small interiors, especially shops and workrooms.

Arc Lamps for all Purposes.—The points to observe in selecting an arc lamp are not difficult either to remember or to act up to: when the purpose of the lamp is decided upon, that type should be chosen which has been widely used and well tried under similar circumstances. In any town this is not a hard matter to ascertain, as a tradesman a few doors away may have been getting increased business out of the attractions offered by a good arc lamp. Arc lamps are now simplified out of all conscience compared to their forbears, and they can confidently be placed in both large and small establishments without dumping an electrician down with them. Simplicity, efficiency, long life, and economy are the characteristics of good modern arcs, and when a specialist is patronised satisfaction will assuredly result. The W. J. Davy arcs, exhibited by Arc Lamps, Ltd., at Olympia, are the embodiment of all that is good in such illuminants. The exhibit included some fourteen lamps lighting the stall and a number of high efficiency flame lamps designed to run twenty-six to thirty hours without retrimming.

Drawing Office Lighting. – Reflected light is the only satisfactory form of illumination for the drafting room. It matters not whether you have two or three draughtsmen or several dozen. They can only work well at night by the reflected rays of an arc lamp. Arc Lamps, Ltd, exhibited a type of lamp which they have supplied in large quantities for this purpose, and which can be employed even when a white ceiling is absent. By the employment of a large reflector, the rays ascending

Patterns of Davy Arc Lamps.
(Arc Lamps, Ltd.)

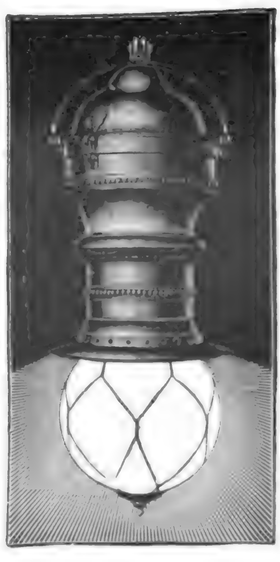
from the arc are thrown back and down into the room, giving an effect equivalent to that obtained by an expanse of ceiling.

Competing with Incandescent Gas.—A strong competitor of the incandescent mantle is the mercury-vapour lamp, a form of illuminant until recently only employed for special lighting purposes, such as photographic work, open spaces, large offices, &c. The lamp is briefly an enclosed arc lamp using mercury in place of carbon. A glass tube encloses the mercury, and when the arc is once started by automatic tilting, a brilliant white light is emitted resembling moonlight. The energy required is remarkably low, about ½ watt per candle-power, and the life of the lamp is limited only by the life of the tube. Two important features point to a big future for the lamp: one is its indifference to pressure fluctuations, the other is the constancy of the light throughout the life of the lamp. The Bastian Mercury-Vapour Lamp, Ltd., exhibited various types of their lamps through their sole selling agents, Messrs. Rumney and Rumney, and judging by the crowded nature of their exhibit, the devices on view were much appreciated. The high economy of this lamp puts it on a competitive level with incandescent gas with this difference: the light is constant, and there is little fear of breakage. At present the lamp is chiefly suitable for exterior lighting, but a domestic form is being developed in which the whiteness of the light is toned by red rays introduced by an incandescent lamp used with it.

Two-light Lamps.—It has often been urged that electric light cannot be turned down like gas, and with reduced current consumption. At one time this was certainly the case, but lamps are now marketed having two filaments, one giving a normal or 16 candle-power and another emitting but 5 candle-power. The reduction of light is made by a simple switch at the side of the lamp collar, actuated by cords descending from the fitting. The use of the second filament ensures both reduction of light and the current consumed, and for bedrooms and sick wards the device is decidedly convenient.

Keyholders.—Lampholders are frequently seen fitted with a key acting as a switch for the circuit. Devices on much improved lines were exhibited at Olympia which remove the objections to this pattern holder and render it more reliable in practice. The push pattern of switch is to be preferred to the key type, as a tumbler motion can be given to the moving parts, and for 200 volt circuits the contacts are less likely to be destroyed by arcing.

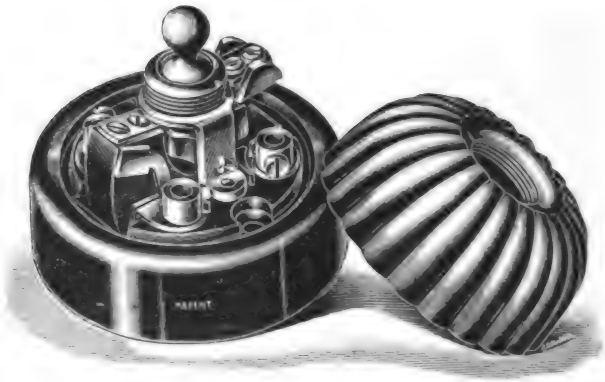
An Electric Table Cloth.—Electric candle lamps are undoubtedly the most perfect lights for table illumination, but unless special arrangements are made the candle fittings must be wired with flexible cord threaded either through a hole in the cloth or arranged as neatly as possible on its surface. Several of the exhibits at Olympia contained examples of table lighting from a special table cloth laid under the ordinary white cover. This comprises a series of copper braid strips extending in rectangular rows around the cloth. A waterproof texture is woven over this and each pole is separated from its neighbour by a row of stitches. The fittings can be used whether candles, statuettes, or pedestals are fitted, with a special current collecting device comprising an ebonite block having two steel points fixed to it. These points pierce the cloth, and entering the braid of different poles complete the circuit of the lamps. The special under-cloth is entirely waterproof and is consequently



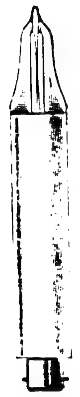
The Globe of a typical Flame Arc Lamp. No Shadows, Complete Diffusion.
(D. Santoni.)

impervious to any moisture which may be spilt during a meal.

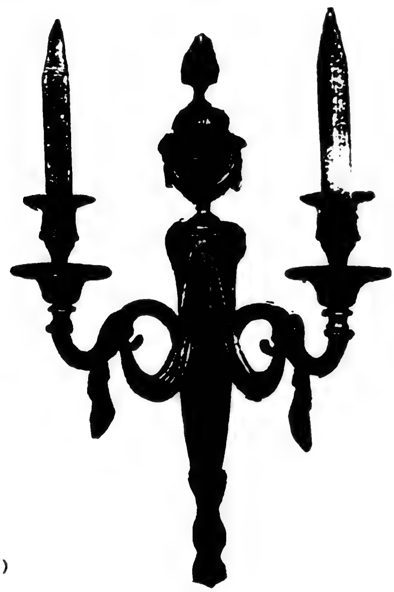
Candle Lamps.—An excellent illustration of the adaptability of the electric lamp is the candle lamp. These are generally fitted into a long opal glass tube resembling a candle. On the stand of D. H. BONNELLA AND SON, LTD., we were shown a new shadeless candle lamp and fittings, the tip of the lamp being an exact imitation of the candle flame. This little device we illustrate, and may say that it has the further advantage of having all its parts renewable. In conjunction with a patent shade carrier very pleasing effects can be obtained with these electric candles.



A TWO WAY SWITCH FOR LIGHTING TWO OR MORE LAMPS FROM SEVERAL POSITIONS.
(A. P. Lundberg.)



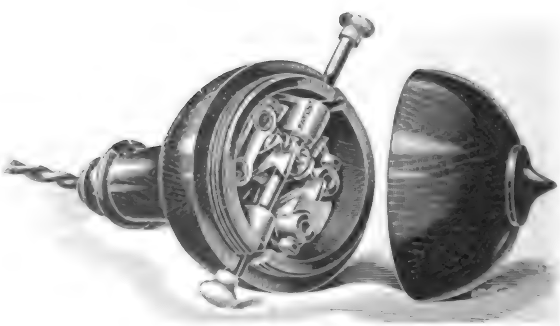
AN ELECTRIC CANDLE.
(Bonnella and Son.)



A TYPICAL ART METAL BRACKET, WITH ELECTRIC CANDLES.
(Ediswan.)

Staircase Switches.—With electric light in the house one can afford to be generous in the lighting of staircases and landings. This applies when only ordinary switches are used, but with a special two way switch a greater number of lamps can be installed. With the two way switch lamps can be turned on and off from either the foot of the stairs or the landing. This convenience can be applied to quite a number of floors, and the advantage of it is obvious. Mr. A. P. LUNDBERG has made a special study of this class of work for many years, and his exhibit was crowded with small wired boards, each of which illustrated some special application of his switches. They can be employed for various combinations in a room: for instance a three light electrolier can be controlled from a central switch, a single switch having three movements, which either puts in one lamp or two or extinguishes all. Similarly in a bedroom, lights over the bed and dressing table respectively can be controlled from two switches, one near the door and the other by the bed-side. A great number of happy combinations of this sort have been arranged for by Mr. Lundberg, and their undoubted convenience in a house is fully testified to by the extensive business which has been built up in their development. Such ideas are, of course, only practicable with properly designed switches, and it is in this particular that Mr. Lundberg has been able to score.

Pear Switches.—When it is desired to light a lamp from a table without leaving one's chair, a switch hung from the ceiling is the most convenient method of attaining this object. Mr. Lundberg showed us a very neat pattern of this switch, and the illustration below will make its construction clear. It has a tumbler movement, and can be conveniently used for 220 volt circuits.



A PEAR SWITCH, WITH INTERIOR REMOVABLE FOR WIRING PURPOSES
(A. P. Lundberg.)

Electric Signs.

ILLUMINATED signs of any kind were at one time a great novelty, and in some quarters they are regarded as an extravagant form of advertising. Since those days, however, opinions have changed, and no great business establishment is to-day complete without some form of novelty of this description. With the incandescent electric lamp many pleasing combinations are possible, and ideas can be put into practical shape much more readily than with either gas or oil as the illuminating source. Electric signs now range from the dazzling and ever-changing monsters on the sky line to the tiny coloured glass case glimmering in shop windows. The tradesman who thinks in big signs must have both hands in his pocket, as advertising of this kind is costly. With large establishments this is, however, no drawback, and as a consequence an extensive business has been built up from the patronage of big houses. At the same time the small shopman is equally well catered for, and his wants, be they ever so exacting, can be readily and cheaply filled.

An attractive sign, whether constantly illuminated or not, will get business in such trades as bakery, confectionery, stationery, pharmacy, restaurants, and similar concerns which depend for success on a quick sale of their goods. Quite inexpensive signs can now be obtained which admit of considerable variety in display, and when in operation are constantly changing colour. Similarly, different wordings can be used, and when judiciously handled the particular shop can be made to constantly attract the passer-by. The British tradesman has, however, still to learn the full value of electric light advertising and the amount of business to be gained thereby. The showrooms, which are now becoming a feature of electricity supply departments, should do much to stimulate the more extended use of electric signs, and energetic shopkeepers should not fail to take their ideas in this direction when in need of technical advice.

A Chameleon Sign.—At the Olympia Electrical Exhibition a decided novelty in stands was that of the CHAMELEON SIGNS CO., LTD. The stall was got up in Japanese style, being furnished and decorated with Oriental ware, curtains, and rugs. On small tables dotted about the stand were placed various designs of self-contained signs, these being the speciality of the firm. The feature of the sign is its property of display both in daylight and at night. It can be built in any shape or size, and comprises essentially an opaque box with glass front and open top. On the glass is painted the required display matter, which stands up in bold relief during the daytime. Behind the glass is a revolving cylinder, fitted either with coloured

A CHAMELEON ELECTRIC SIGN AS IT APPEARS BY DAY. THE LETTERING WHEN LIGHTED UP IS BEAUTIFULLY VARIEGATED IN DIFFERENT COLOURS.

mica panes or any figure, for projection on the glass front. Inside the cylinder is the illuminant, which may be either oil, gas, or electricity. The heat rising from the lamp impinges on a small fan wheel attached to the cylinder and suspended on a sharp steel pivot. The pivot rests on a jewel, and the device is so delicately balanced that it will revolve by the heat rising from the hand. Quite a variety of designs were displayed on the stall, and a very pleasing and attractive result was obtained in each case. By the adjustment of the angle of the blades in the fan wheel any desired speed can be obtained. We understand that speeds as low as one revolution per minute can be ensured. An amusing sign was an imitation of an Oxo bottle, on the front glass of which was painted a smaller bottle lying on its side. On the revolving cylinder oxen were painted, and when in operation the sign gave the impression of the animals walking into the bottle. Similarly, a large plaice was shown, and through a circle in its centre appears a fish bowl in which shoals of fish of all kinds seem to be swimming about.

Constant Variety.—Chameleon signs are adaptable to anything, and to a tradesman requiring a simple device which enables him to obtain constant variety they are a most effective form of advertising. Numerous sets of cylinders can be supplied with the sign, and the changes can be rung on these over an extended period. It has one great advantage over other changing signs, in that no extra current is required to produce the various effects. This is one of its strongest recommendations to the small tradesman. It can, of course, be applied on a very large scale, and, as we have said, to suit any special requirements. On our own stand at the Exhibition we had a large sign in constant operation, the design being an imitation of our cover lettering. It proved a great attraction and elicited quite a number of enquiries.

A Wireless Sign.—Electric signs are now beginning to find favour with the small shopkeeper because a supply has arisen to meet his needs. An ideal sign is one giving the tradesman a wide choice of lettering which can be constantly changed. By "constantly" we mean once or twice a day and not every few seconds. The public are caught more by a "piquant" sentence than by ever-varying words, and the proprietor of an establishment will frequently find himself famous for his "signs." The wireless sign of the EPANDEM COMPANY is a decided novelty and at Olympia made quite a stir. It is a simple arrangement, comprising two bars, opposite poles of a circuit, between which the feet of different letters are pressed. Each letter is picked out by numerous tiny lamps which require only a low voltage to illumine them. Each letter with upwards of eighteen lamps will consume energy equivalent to an 8c.p. incandescent lamp, and the sentence or word can be changed at will.

VIEW OF WIRELESS SIGN, SHOWING METHOD OF REPLACING LETTERS. (Epandem Company.)

A Prismatic Sign.—An electric sign need not necessarily be constantly changing to be attractive. Effective illuminations with or without colours will prove quite as much a draw as if some weird kaleidoscopic effect is produced. We noticed a very good sign on the stand of D. H. BONNELLA AND SON, LTD., which is fitted with a great number of multi-coloured reflectors fixed in front of a fluted mirror. The light is distributed by these, and the mirror lends brilliancy to the effect obtained. With quite a small lamp this sign when arranged in various letters is readily distinguishable many yards distant. As no special lighting devices are required the cost of upkeep is very small.

To Catch the Eye.—By reason of its adaptability, the electric incandescent lamp is *the* thing for sign lighting. Effective permanent signs can be made up cheaply with a number of holders, suitably supported, and the lamps are then inserted to give the desired illumination. The display of lamps made by the various makers was admirably illustrative of what can be done in this direction. THE EDISON AND SWAN COMPANY studded the ceiling of one section of their exhibit with rows of lamps controlled by several switches, and the manipulation of these produced some charming effects.

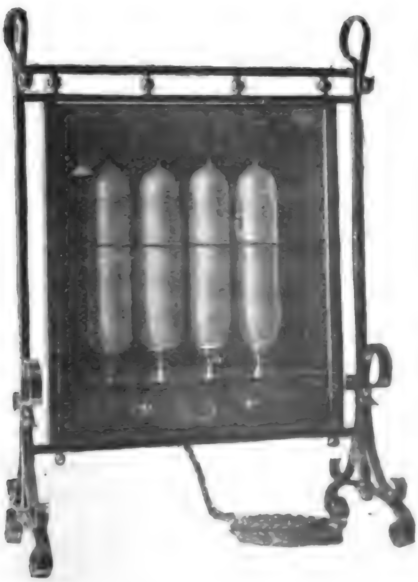
Rainbow Colours.—There is no limit to the use of colours with electric signs, the most daring schemes being quite feasible in practice. The lamp globes can be lacquered to any desired hue, and control switches operated by a clock will bring certain combinations into glow at a given moment. Robertson lamps were displayed in this way at Olympia, the monster luminous sign over the stand where lamps were made being capped with a sign in colour which flashed up different letters at intervals. The combination with the displayed lettering below was most effective. Too much emphasis cannot be laid on the fact that the electric sign pays, and pays well, as an investment. A week has often produced business covering the initial cost and the running of the sign.

Heating by Electricity.

The idea that electric heating is an expensive luxury has gained considerable prevalence, and no determined effort has been made to combat it. In great measure this is due to the extremely rapid spread of electric lighting, with a consequent difficulty in keeping pace with the demand. In the pioneering days electrical energy was primarily used for lighting purposes, and such requirements as heating and power were not originally developed to any extent. The lighting branch of the industry has consequently obtained a good lead, which it has every appearance of maintaining for some time to come.

Electric heating is, however, now receiving its due meed of attention, and with the prices at present prevailing in all towns giving an electricity service it should become very popular. When we say electric heating we mean the application of electricity for the warming of rooms and domestic utensils, and for cooking. With the electric heater there is neither smoke, dirt, nor smell. The heating device, no matter what its purpose, can be moved from place to place as required. A radiator, for example, can be set near the person or persons requiring its warmth. This portability is analogous to moving a fire about a room. With the latest patterns of radiators both heat and light are emitted, and the cheering blaze of a coal fire is well imitated. The distasteful domestic operations of handling wood and coal in preparing a fire are dispensed with, and on this account considerable economies are possible in the electrical device, in that the heat can be turned on and off as needed.

With current at 1d. per unit electrical energy for heating purposes will be equivalent in cost to gas at about 3s. These figures are comparative only, but as gas quite frequently exceeds this figure, and electricity is not everywhere obtainable at so low a price, it may be considered that electric heating would be rather more costly than gas. With electricity, however, there are no fumes, nor can an explosion take place, as when gas is allowed to accumulate in confined spaces. With an electric heater almost the whole of the heat given off is utilised, as the losses from radiation are very small. Again, although the heat derived may be very intense, it is entirely concentrated on its work, so that the device is quite safe to handle and fire risks are entirely obviated. The chief charm of electricity for heating is its adaptability to the particular article in which the heat is to be utilised. The devices illustrated in what immediately follows have each been fitted with an electric heating element, and in the case of ordinary domestic utensils they can be used with perfect safety on an ordinary table.



RADIANT HEAT GLOW LAMPS IN SPECIAL RADIATOR. (Dowsing.)

ORNAMENTAL RADIATOR. (G. E C.)

Prometheus Heaters.—The progress made in the development of electric heating apparatus was admirably typified at the stand of the BRITISH PROMETHEUS CO., LTD. This exhibit was the only one in the Exhibition devoted exclusively to domestic electric heating and cooking. Upwards of 300 designs were on view, and the most extravagant and most economical tastes in electric heating and cooking apparatus were catered for. In the Prometheus system one or more heating strips or units are employed, these being arranged in such a manner that renewal can at any time be effected by the user. Our illustration of a saucepan fitted with a Prometheus strip will make the simplicity of the system at once evident. It is not impossible to burn out this strip, but should it be fused at any time, its replacement is neither a costly nor difficult matter.

Electric Convectors.—The pattern of heater adopted by the Prometheus Company for use in rooms, offices, &c., combines the heating properties of the Prometheus strip with the glow of the incandescent lamp. The lamps are used to imitate the blaze of live coals, but they form no part of the heating circuit, this being made up of a number of horizontal strips placed in front of the convector. These heaters are manufactured in either the simplest or most ornate styles, and the most exacting requirements can be met. The temperature is regulated by switching a greater or lesser number of strips into circuit, switches being fitted for this purpose.

Varieties in Heating Apparatus.—One of the beauties of electricity for heating purposes is its direct application to the utensil in which the heat is to be utilised. Each saucepan, stewpan, jug, and kettle is provided with its own heating apparatus, and can be carried about from one room to another. We illustrate examples of Prometheus appliances of this character, and it will be noticed that, despite the heat given off, the addition of the heating element adds but little to the size of the article.

Electric Hot-plates.—An electric hot-plate is strongly recommended to those desirous of experimenting with electric heating. The initial outlay is much smaller than if separately heated utensils are purchased, and a variety of

ELECTRIC STEWPAN OR SAUCEPAN.
(Prometheus.)
Notice metal strip clamped around bottom of pan. This gives the requisite heat and can be renewed if burned out

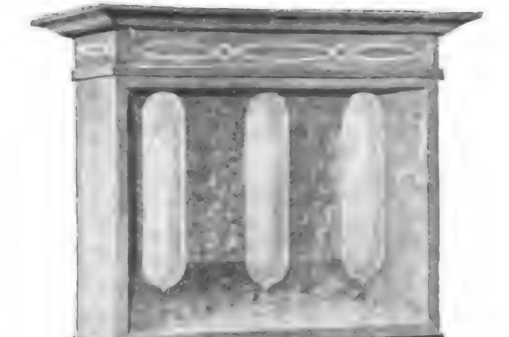
An Electric Hot-plate with Heat Regulator.
(Prometheus.)
This class of heater is strongly recommended to those first using electric cooking apparatus.

cooking operations may be carried out with it. The Prometheus hot plates are arranged with temperature regulation so that when the maximum heat is obtained the current to maintain it can be reduced. Utensils employed must, of course, have an absolutely flat-bottomed plate, to ensure a uniform contact and reasonable efficiency. The ordinary operations of boiling and stewing can be performed on one of these plates, and as the advantages and economies of electric cooking become evident, further expenditure on independently heated utensils can be made.

A Neat Electric Kettle on Table Stand.
(Prometheus.)

Radiator Designs.—The electric radiator must not be confused with a convector or air warmer. Radiant heat acts by heat rays which pass through the air, warming objects in the immediate vicinity without raising the air temperature appreciably. People must be educated up to the economic value of electric heating: at present the room is warmed and much heat wasted thereby, whereas the radiator by its portability can be transferred from place to place and its rays applied where needed. Not only is the method economical in so far as current consumption is concerned, but it is productive of more healthful results. We are inured to the coal fire by centuries of grate habits, and our complete *abandon* to this method of heating compels blind acquiescence to its many evils. Break down the prejudice against isolated radiators as opposed to

Artistic Electric Convector for Heating Rooms.
(Prometheus.)
Small lamps give a pleasing glow, but heat is provided by strips of resistant metal.



Electric Radiator in Wood Frame, with Copper Reflector.
(G. E. C.)
A neat pattern to match furniture, &c.

A Convenient Application of Electric Heating. Warming-pad for Invalids, &c. (G. E. C.)

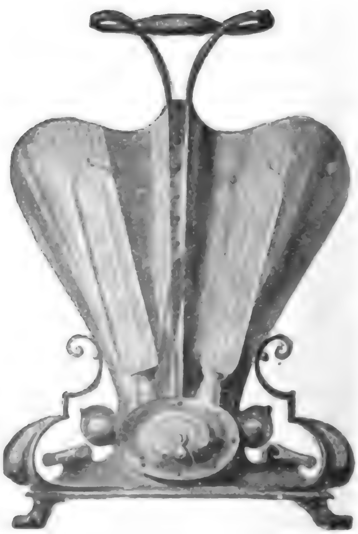
wasteful and insanitary heating by coal, and the way to electric warming is made clear. In the field of electric heating the General Electric Company has been active for many years; in fact, almost since the industry could claim any respect, and interest attaches to their apparatus as exhibited by reason of its illustrious forbears. The illustrations on these pages are typical of G.E C. electric heating appliances, and, moreover, they exemplify all the latest designs.

No Limits to Electric Heating.— The principle whereby electrical energy is converted into heat can be applied to any commercial article requiring heat. No matter how small or large that article may be, the necessary heating units can be made an integral portion of the device. In addition to being adapted to the most common domestic utensils, electric heating has "created" devices distinctly its own: inimitable by gas heaters of any kind. On this page will be noticed illustrations of an electric warming-pad, a cigar-lighter, and a frying-pan (General Electric Company); these are distinctive forms of electrically-heated articles which give a new aspect to the employment of the thermal properties of electrical energy. The warming-pad can be used for twenty hours at a cost of 1d. (1d. per unit), and the cigar-lighter will require much less, as it is only in circuit a few seconds at a time. The frying-pan requires a farthing an hour to operate it in small sizes, and a halfpenny in larger forms. It will be obvious that current is only consumed as needed, the circuit being broken when the utensil is not in use.

Electric Cigar Lighter—a Popular Electric Heating Device. (G. E. C.)

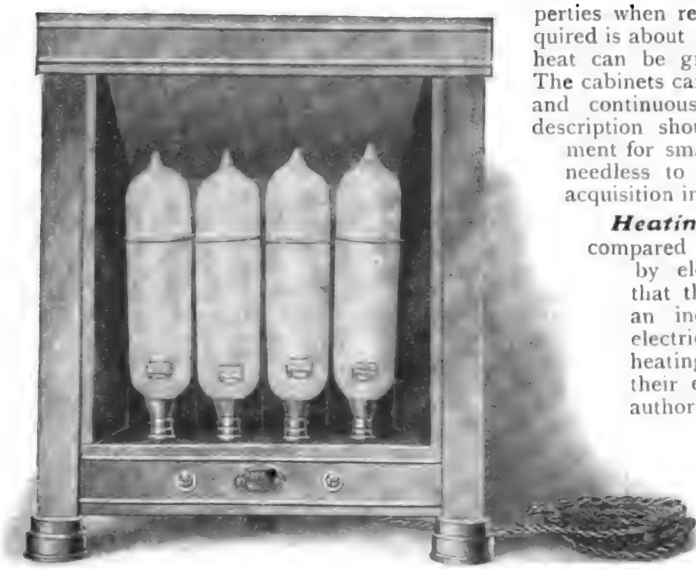
Hygienic Heating. — The glow lamp form of radiator is unique in that it is the essence of portability. It was conclusively proved at Olympia that public interest in these radiators has been stimulated, and with a reduction in prices in London by some companies to 1d. per unit for energy for heating, there should be a boom in these handy radiatois. The principles of hygiene demand that so sanitary a device should find wide acceptance.

Electric Stewpan. (G. E. C.) Costs a farthing per hour to run.



Bedroom Electric Radiator, with Fluted Copper Reflector. (G. E. C.)

Radiant Heat.—The notion once prevalent that electric heating would never become popular until something like a coal fire could be evolved is in great measure responsible for the tardy development of electric radiators. The system introduced by the DOWSING RADIANT-HEAT COMPANY, who exhibited many examples of their heating devices at two large stands at the Exhibition,



A LARGE PATTERN RADIATOR, WITH ADJUSTABLE HEAT SWITCHES.
(Dowsing.)

has done wonders for the expansion and more general use of electric radiators. Heat and light are its chief features, and account in great measure for the popularity of the luminous electric radiator. The radiators are now familiar objects, and need little or no description. A number of long incandescent lamps are placed in a row and backed by reflectors which throw forward the heat rays into the room. A compact form of heater is the result, and in addition the device is quite light and portable. The radiator is rendered highly efficient by the use of inclined reflectors which form triangular channels. Through these channels the heated air rises and, striking the radiator top at angle, is impelled into the room. The effect of one of these radiators is very pleasing, and they are economical to use where the cost of electrical energy for heating purposes is not excessive.

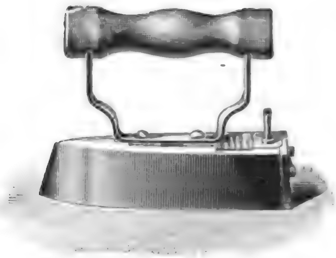
Sun Baths.—Users of electrical energy can at comparatively small cost take sun baths at home. The Dowsing Radiant-Heat Company manufacture what they term the "Solarium," this being a cabinet containing a number of electric lamps under the control of the person using the bath. It is claimed that this device is a considerable improvement on cabinet baths employing hot air. It does not depend upon the heating of the air only, as direct light and heat rays are thrown upon the body from the special electric lamps used. These cabinets are extremely convenient, and will be found to have great health-giving properties when regularly used. The energy required is about half a unit, and the amount of heat can be gradually raised and lowered. The cabinets can be used for both alternating and continuous current. A bath of this description should prove a profitable investment for small medical practitioners, while, needless to say, it would be a distinct acquisition in large sanatoria.

Heating Costs.—We have already compared broadly the cost of heating by electricity and gas. We hope that the Olympia exhibition will be an incentive to present users of electricity for light to *try it* for heating and cooking, and to give their experience to the local supply authority. This will entail little trouble, and where satisfaction resulted would tend to increase the heating business, and thereby reduce the local tariff.

ANOTHER PATTERN OF LARGE ELECTRIC RADIATOR.
(Dowsing.)

Medical Electricity.—The value of light and radiant heat baths to patients suffering from certain diseases has now become apparent to the medical faculty, and where electricity supply mains are available advantage should be taken by individual practitioners of the benefits they can convey. A comparatively low capital cost will provide an equipment which would, by its constant use, quickly repay the initial outlay. The benefits of medical electricity should not be confined to great hospitals, but be available by those who rely on local advice for treatment of their ailments. We cannot reiterate the many diseases and minor complaints which will succumb to electrical influences, but we may mention the elaborate display of electrical apparatus by the Dowsing Radiant-Heat Company, in which the latest forms of electro-medical devices were exhibited. The apparatus included heat baths, high frequency appliances, electro-vibrators, &c., and was inspected by both the curious crowd and the interested professional. A physician nowadays must move with the times, and in the matter of adopting electro-medical apparatus a half-hour's conversation with the engineer of the local electricity supply authority would put him in possession of all the facts.

Aston Radiators. — At the exhibit of VERITY'S, LTD., was a large display of electric warming stoves. These comprised essentially a number (from two upwards) of long frosted glow lamps provided with specially shaped reflectors to throw forward the heat of the lamps. This method of transmitting the heat into a room keeps the back of the reflector comparatively cool, and it can be placed with safety against a wall, a piece of furniture or any delicate fabric without fear of scorching. Radiators of this pattern are now familiar sights in many shops and offices, and when their economies become better known they should be very widely used. Unlike the early black-leaded type they emit both light and heat, and at some little distance it is possible to read by their rays. Quite a variety of patterns were exhibited by Messrs. Verity's, and the most exacting requirements in the matter of ornamentation can be met by their standard forms. Three and four lamp radiators are fitted with two switches so that the degree of heat can be regulated. With current at 1½d. per unit two lamps can be operated for about ½d. per hour, and a room 9ft. square could be effectively warmed at this cost.



ELECTRIC IRON.
(Verity's, Ltd.)
(A flexible conductor conveys energy to the heating element.)

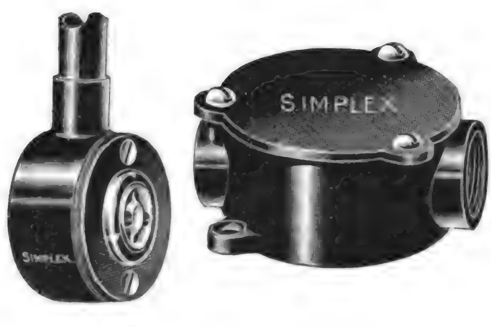
Cooking Utensils.—At the same exhibit a variety of cooking utensils was on view, including kettles, flat-irons, hot plates, jugs and grills. Each of these is fitted with a patent safety device which automatically breaks the circuit should the heater be raised to an excessive temperature. This device protects the resistance coils from injury, and after operation it can be renewed at a very small cost. We noticed also a contrivance for drying ladies' hair, this comprising a vertical cylinder containing two heating lamps surrounded by a wire grid. On this latter the hair is placed and a small fan in the base of the cylinder forces the heated air through the damp folds, drying them with safety in a few minutes.

HANDSOME RADIATOR FOR LARGE ROOMS. TWO OR MORE LAMPS CAN BE LIGHTED AT A TIME.
(Verity's, Ltd.)

The Wiring of Buildings.—Prospective consumers of electrical energy, whether for lighting, heating, or power purposes, are naturally interested in the best methods at present produced for leading the wires about buildings. Wood casing is by no means as popular as formerly, nor does it make so substantial a job of the work. It is now general practice to employ steel tubes to thoroughly enclose and protect the conductors. The SIMPLEX STEEL CONDUIT COMPANY embodied in the design of their stall almost every length, elbow, T piece, junction box, and special fitting employed by their system. We illustrate two examples of the specialities in wiring work introduced by this company. Limits of space prevent our going into details of the many improvements in conduit systems which have been introduced by the Simplex Company, but we can at least strongly recommend the use of their system wherever electric lighting and power work is undertaken. The illustration which we give of the company's stand clearly indicates the sound mechanical properties of the system.

Simplex Specialities.—An enclosed system of wiring is practically a necessity where damp buildings and underground premises have to be supplied with electricity. On this account the Simplex method has great advantages over wood casing or any other form of protection given the conductors. The various circuits can also be more neatly arranged on walls or behind plaster, giving a uniform finish to the whole installation. This uniformity applies also to the bringing of wires into switches, ceiling-roses, wall-plugs, &c., and with the tubing screwed an absolutely damp proof system can be built up. Where motors are installed a tube covering for the wires is essential in leading up to the motors themselves, as cleaners and fitters may be constantly around the plant, and badly protected wires would speedily become damaged.

Electrical Fires.—So much has been said in the lay Press anent the dangers of electrical installations, that in referring to wiring matters we may well introduce the subject again. While not denying that fires have been caused by bad workmanship in wiring buildings, we must strongly refute any statement which brands an electrical installation as in any way dangerous. Like everything else electrical, vast improvements have been introduced into wiring materials, and to-day, with the introduction of these by competent workmen, there is not the least risk of fire. Steel tubes reduce the amount of combustible material around the conductors, and when properly bonded they act as a safeguard against conflagrations. Cheap wiring should be avoided like poison, but contractors are available who will work for a reasonable figure and yet introduce only the best material.



SIMPLEX WALL PLUG AND JOINT-BOX.

THE EXHIBIT OF THE SIMPLEX STEEL CONDUIT CO., LTD.

D. P. MAIN SWITCH.
(J. H. Tucker and Company.)

Telac Apparatus.—When electric lighting and power installations are done well, the best materials are used for such accessories as switches, fuses, &c. Improvements are constantly being effected in these designs, and they tend to raise the general standard of excellence of electrical accessories. J. H. TUCKER AND COMPANY in their exhibit gave evidences of this forward movement, and the examples on this page represent a main switch and single pole fuse which should find extensive use. The switch parts are substantially made, and when the cover is closed and sealed it is only possible to put the switch on or off as required. The fuse can also be closed and sealed, while at the same time it will safely break the circuit without doing external damage. Messrs. J. H. Tucker and Company also make every variety of switch and fuse as well as large switchboards for both public and private supply installations.

S. P. MAIN FUSE.
(J. H. Tucker and Company.)

Dead Wiring.—An expression commonly used by electrical engineers is that a circuit is "alive" when current is supplied to it, whether that current be doing useful work or not. With the ordinary wiring methods the greater part of the installation is alive, and remains so during the hours of daylight. In this condition any defects in the wiring will show themselves. A system has now been devised whereby only that section of wiring required is under current, and when no lights are burning the supply is interrupted at the main. Mr. A. Blackmore is the inventor and manufacturer of this system, which consists essentially of a power magnet actuated by relays from a local battery circuit. The house or premises is wired with the small leads, and pushes take the place of switches at the control points. The main conductors are taken directly to the lights and not to switch points. All the controlling devices are in a compact box placed in the basement, and kept under lock and key if necessary. It is claimed that the cost is not increased, and, as joints are eliminated, that fire risks and leakage are entirely done away with.

ORNAMENTAL TUMBLER SWITCH
(London Electric Fitting Company.)

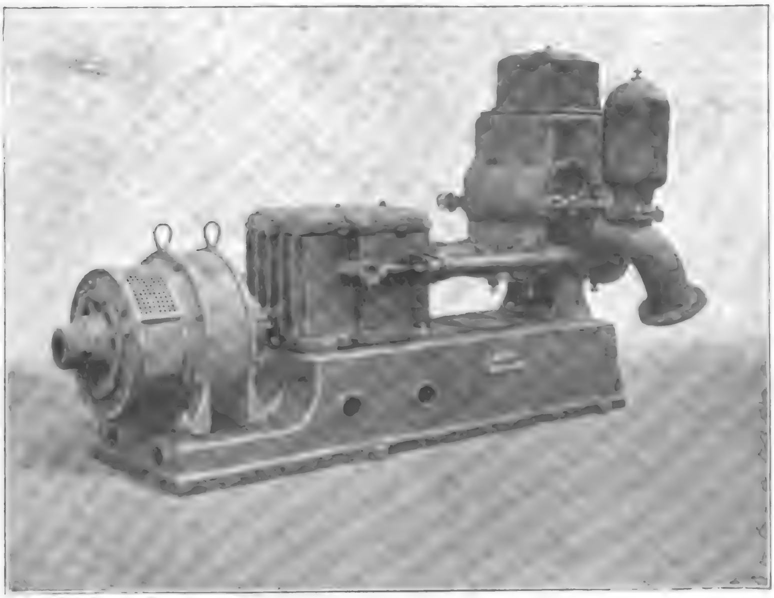
Ornamental Switches. — The standard fluted cover for tumbler and other switches is frequently replaced by something more ornate to match the appointments of a room. There is no limit to the elaboration of switch covers, and, where money is no object, beautifully chased metal, ivory, and other costly materials can be introduced. Unlike a gas fitting, which is begrimed and frequently destroyed by fumes, a *chef d'œuvre* in switches is a constant treasure to its user.

The Development of the Electro-motor.

An outstanding feature of the Olympia Electrical Exhibition was the great number of examples of electro-motors and their application to the driving of various pieces of industrial apparatus. The improvements made in the electro-motor have placed it in an unassailable position as a power agent. It is destined to displace the many thousands of isolated steam and gas engines now used in both the large and small trades requiring power. When industrial concerns really awaken to the advantages which electric driving confers, a demand for cheap power will be created which will be met with avidity by electricity supply authorities. There is no lack of manufacturing concerns to produce the motors, nor is there scarcity of power stations from which to operate them. What is needed at the present moment is the unqualified support of power users.

The Olympia Electrical Exhibition must have done a good work in affording to the public an unique opportunity of observing in operation many motor-driven devices. It should also have been clear from the makers' exhibits that the electro-motor as at present produced is an almost perfect piece of mechanism. It may rightly be termed a triumph of manufacturing skill, while it contains all those elements of simplicity which have made it so popular.

As an ideal power machine the electro-motor is especially commendable for those trades in which small gas and oil engines are frequently fixed in cellars, out-houses, &c. On the grounds of economy and all-round mechanical efficiency the electro-motor has no rival, while in the matter of adaptability there is no power agent like it. Electrical energy for power purposes is everywhere obtainable at a low figure, and the tariff is constantly being reduced. There are prospects of the prevailing prices being halved at no distant date, and the final limit is not yet in sight. The machines exhibited at Olympia differed chiefly in outward appearance only. Each maker does the same thing in a slightly different way to his *confrère*, but the result in the majority of cases is very similar. On all points the electro-motor as a secondary power machine cannot be beaten, and power users should lose no opportunity of putting themselves in touch with the local supply authorities with a view to getting all possible data available regarding the adaptability of the motor drive to their particular machinery. Canvassing and general development departments are now being opened in connection with electricity stations, and prospective customers need never be at a loss for technical information.



Electrically Operated Pump. (Crompton and Co., Ltd.)

Motors and their Application.

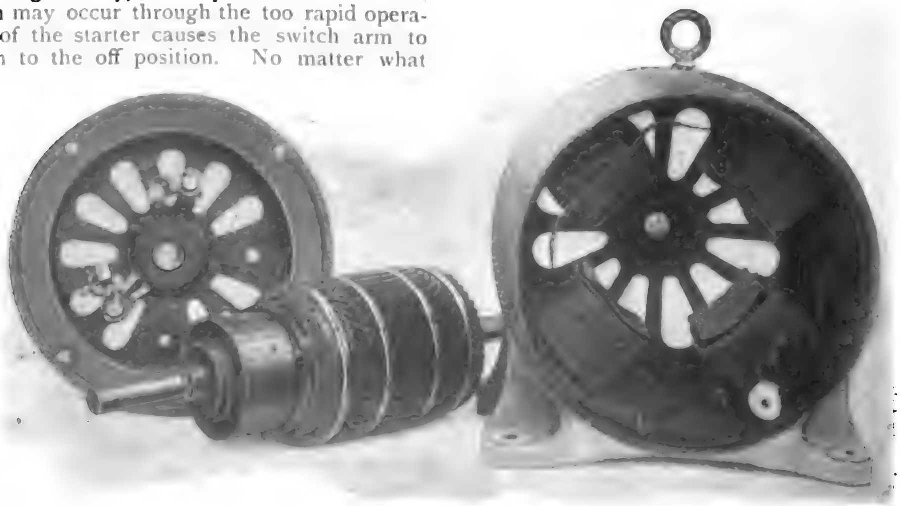
Stellite Motors.—A range of continuous current motors made by the ELECTRIC AND ORDNANCE ACCESSORIES CO., LTD., was exhibited at their stand in the body of the hall. A series of motors ranging in output from ¼ to 15h.p. was shown, the designs including protected and totally enclosed types. We also noticed motors with worm reduction and back gears. A number of interesting motor applications was to be seen about the stand. Small-sized motors were in operation driving sewing machines, drills, and polishing wheels. A special feature was made of motor-driven fans, and among these we noticed a neat form with a universal adjustment which admits of its use for wall, table, desk, or ceiling.

Motor Controllers.—A good motor controller should be efficient, reliable, and practically fool-proof. The life of a motor is governed almost entirely by the type of starter and controller used with it. The "Stellite-Gradual" motor starter and regulator appears to fulfil these conditions in every detail. It will be noticed from the illustration that the contact arm is fitted with a small magnet which engages with a pivoted armature on the switch arm. The latter is normally carried to the extreme left by the aid of a spring, and to start the motor the loose arm is brought to the left, and the magnet of it becomes energised sufficiently to hold the switch arm firmly, and allow of its travel over the stops. Both arms will remain in any position; but should the current cease from any cause, the switch arm immediately returns to the off position. The motor *must* be started gradually, as any excess of current which may occur through the too rapid operation of the starter causes the switch arm to return to the off position. No matter what

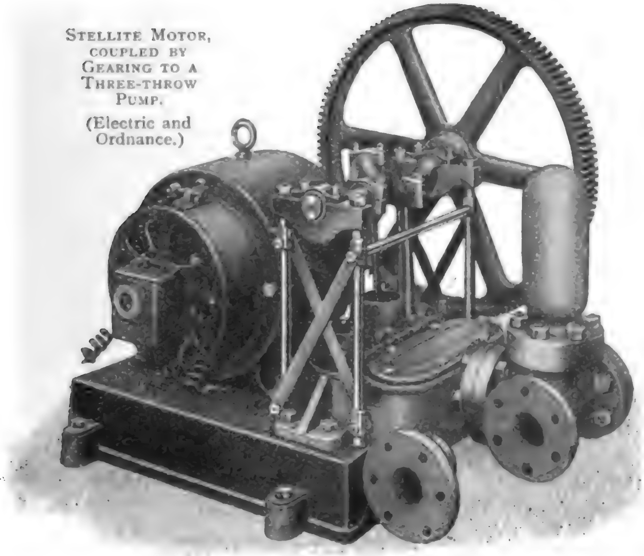
STELLITE-GRADUAL STARTER WITH POSITIVE OVERLOAD RELEASE AND MINIMUM CUT-OUT.
(Electric and Ordnance.)

attempts may be made to start the motor quickly, this release effect prevents a rush of current every time. The overload tripping coil will be noticed to the left of the illustration. This arrangement dispenses with all complicated mechanical gear, and we understand the starter is marketed at a reasonable price.

Crane Controllers.—At the same stand was exhibited a special line of crane controllers of the tramway drum type. The Electric and Ordnance Accessories Company have had an exceptional experience in the design of this type of controller, and many valuable features are



STELLITE MOTOR SHOWN DISSECTED. (Electric and Ordnance.)
The simplicity of the parts is at once evident.

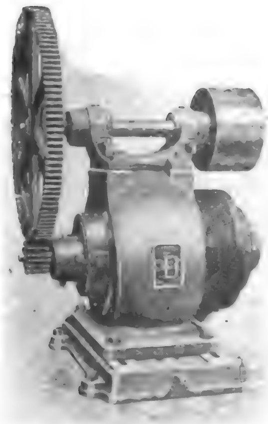


STELLITE MOTOR, COUPLED BY GEARING TO A THREE-THROW PUMP.
(Electric and Ordnance.)

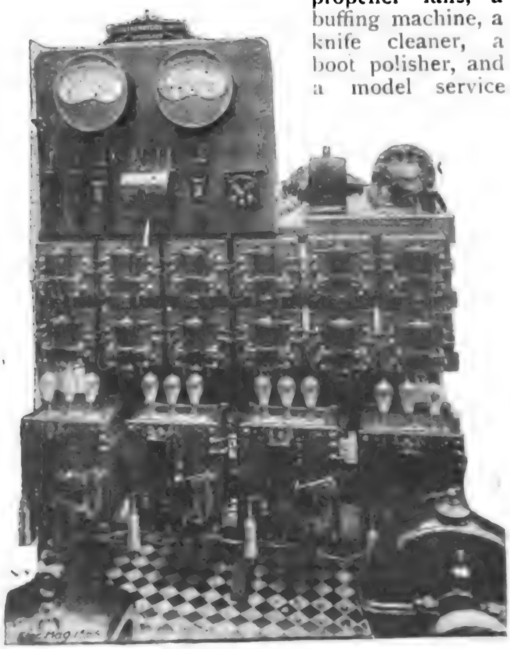
embodied in it. No wood or fibre is used and the contact fingers are placed in separate insulated compartments. A powerful magnetic blow-out is provided and the parts are fixed to admit of easy inspection. A ball-thrust bearing takes the weight of the drum at the lower end. The starters are arranged for reversing, compound and two voltage control with or without breaking points.

Electromotors, Ltd.—The exhibit of ELECTROMOTORS, LTD., was a striking illustration of what can be done by specialised manufacture. In a utilitarian age we have learned to respect the specialist because he can produce a better article at a cheaper rate than the manufacturer who dabbles with half a dozen different things.

Electromotors, Ltd., confine themselves, as is generally known, to the manufacture of motors and dynamos from ¼h.p. to 25h.p. capacity, and have successfully applied their machines to innumerable industrial purposes and apparatus, such as can only be undertaken by specialists in this class of work. Examples of their direct current motors with capacities from ¼ to 25b.h.p. were arranged on the stand. A plain electric motor is not much of an attraction, but in this particular instance the public was "drawn" to the stand by the automatic starting and stopping of the motors on show. It was interesting to note the speculations of the observers as to which motor would start next, and at times quite an eager crowd gathered to see what was going on. Twelve motors were connected up, started, and stopped at half-minute intervals by a revolving switch operated by a ¼h.p. motor. Solenoid switches and rheostats put the motors in circuit and brought them up to speed. The diagram on page 37 will make the connections quite clear. The company's motors were shown operating propeller fans, a buffing machine, a knife cleaner, a boot polisher, and a model service

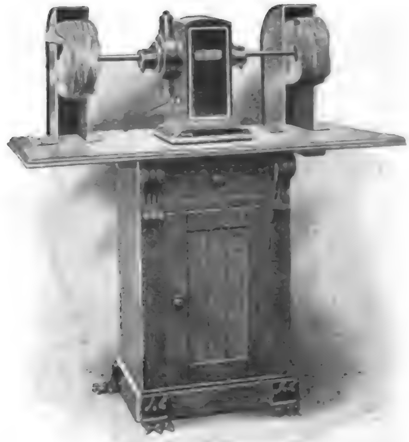


BACK-GEARED MOTOR.
(Electromotors, Ltd.)



AUTOMATIC SWITCHES AND MOTOR-DRIVEN CONTROLLER SHOWN AT STAND OF ELECTROMOTORS, LTD.

Motor-driven Propeller Fan.
(Electromotors, Ltd.)



Boot Polishing by Electricity. Motor-driven Polishing Wheels.
(Electromotors, Ltd.)

lift. The latter was manufactured by J. G. Childs and Co., Ltd., and controlled by push buttons from any floor.

Electric Propeller Fans.—Pure air in a building should not be considered a luxury; it is a necessity, and can be most cheaply and conveniently obtained by using an electric propeller fan. Three fans of this class were shown in operation at the stand of Electromotors, Ltd. Where silent running is especially desirable, a slow speed fan is recommended. For the electric propeller fan the makers claim a minimum current consumption for a maximum of air moved. The fans are standardised for sizes from 15in. to 40in. in diameter, and are also made for higher speeds. We give a useful table showing the energy absorbed by the different standard sizes both for high and slow speeds.

Dia. of Fan.	Slow Speed.			High Speed.		
	Revs. per Min.	Cub. Ft. per Minute.	Watts absorbed Approx.	Revs. per Min.	Cub. Ft. per Minute.	Watts absorbed Approx.
15	750	1400	44	1100	2100	150
17½	750	2330	130	900	2800	[illegible]
20	600	2800	150	750	3500	[illegible]
25	550	4950	240	700	[illegible]	[illegible]
30	420	6500	300	[illegible]	[illegible]	[illegible]
35	375	9300	390	500	[illegible]	[illegible]
40	330	12 00	530	450	[illegible]	[illegible]

Electric Knife Cleaning.—The advantage of an electric knife cleaner lies in the increased speed at which this simple domestic operation can be performed. It is chiefly advantageous in restaurants, hotels, and large houses. Electromotors, Ltd., were exhibiting a motor-driven knife cleaner, having a capacity of 1,000 knives per hour, the motor having been specially designed for the purpose. As will be seen from the illustration the device is exceedingly neat and very compact for the work got out of it.

Motor Boot Polishing.—In large commercial establishments such as hotels and boarding houses the saving of time is conducive to increased patronage of guests. Where many hundred pairs of boots are to be polished a machine only can deal quickly with them. Electromotors, Ltd., exhibited an electrically driven boot polisher which will

Electrically-driven Knife Cleaner. 1,000 Knives per Hour.
(Electromotors, Ltd.)

New Pattern Brush Holder of Electromotors, Ltd. (Brush is in off position.)

save its cost in a few weeks. As will be noticed, it is compact and neat, and has no wearing parts to adjust or get out of order. The buffing discs are driven at high speed by the motor and they will clean boots without scratching or marking.

A Unique Brush Holder.—The brush holder is to the direct current motor what the dinner is to the man—an indispensable accessory. The man, however, if he be of the ordinary type, pays greater attention to his dinner than his motor brushes, and unless these latter can take care of themselves they fare badly. Electromotors, Ltd., have produced their "Perfect" brush holder at a happy moment, and in the design adopted they have produced as nearly fool-proof a contrivance as is conceivable. The illustration explains the thing at a glance, and we can sum up our description of the device in a few words. The working parts are entirely enclosed, protected from dust and dirt, and substantially made. The brush lifts well clear of the commutator into a positive off position, and when worn down reaches a point at which the brass parts cannot score or imbed themselves in the commutator. The carbon block is readily removable, and automatically adjusts itself for wear to the commutator face. This is the neatest thing we have yet seen in brush holders, and, as it requires no attention, is highly commendable for continued service on motors in the hands of non-technical men.

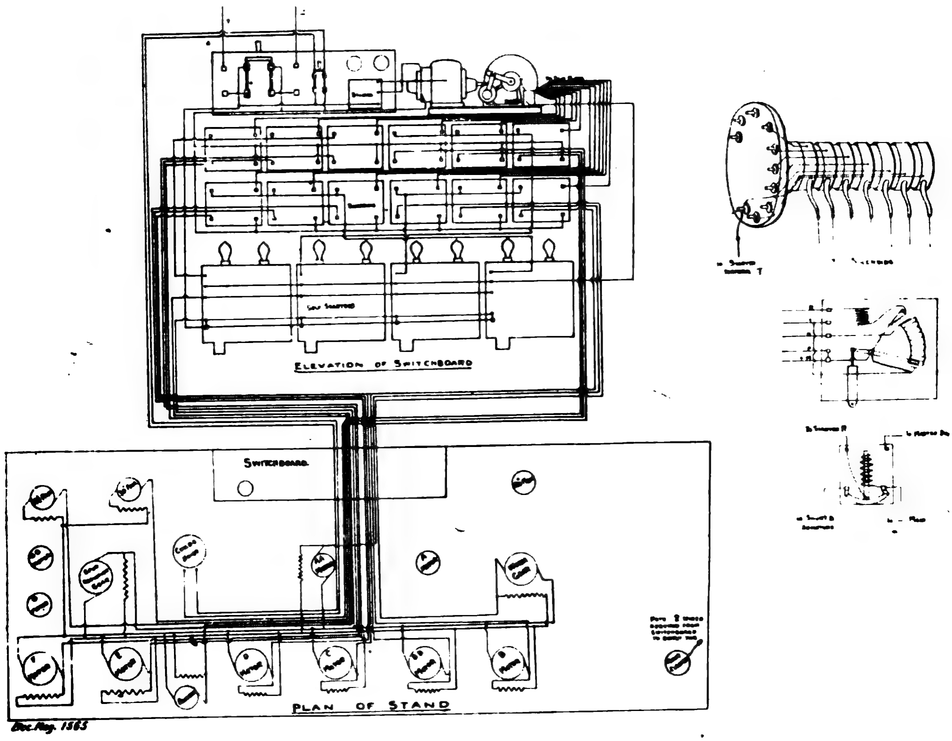


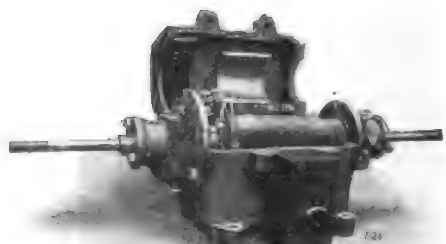
Diagram of Connections for Automatic Motor Starting Apparatus on Stand of Electromotors, Ltd.

Variable Speed Motors.—A characteristic feature of the electro-motor is the wide speed variation possible without use of mechanical accessories. Up to certain limits the range of control can be pushed without the use of a special motor, but beyond, the form of the magnetic field must be altered to ensure sparkless running at the commutator. At the stand of the PHŒNIX DYNAMO MANUFACTURING CO., LIMITED, was exhibited a class of motor which admits of a speed variation of 1 to 5 without sparking at the brushes. This result is obtained by the use of auxiliary poles which keep down the armature reactance voltage at the moment of commutation and thereby minimise sparking. The advantage of the auxiliary poles in a motor lies in the greater speed variation obtainable with fixed brushes and simple rheostat. In addition the motor for a given output can be made smaller.

PHŒNIX ELECTRIC DRILL FOR BENCH OR PILLAR USE.

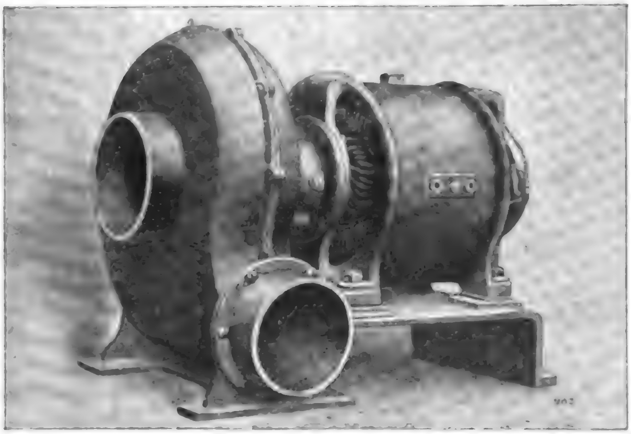
The Phœnix Electric Drill.—An object of general attraction on the Phœnix Dynamo Company's stand was the Phœnix electric drill, which we illustrate. This is a handy little tool indispensable for both small and large workshops and remarkably efficient. As will be seen, the motor is mounted with horizontal spindle at the back of the drill standard and drives by friction wheel and disc on to the vertical drill spindle. Four speeds can be obtained by moving the friction wheel towards the outside of the disc, and anything up to a 1in. drill can be used. The device is remarkably powerful, and at the Exhibition demonstrated its capacities for quickly drilling metal. We saw thirteen ½in. holes drilled through a piece of ¾in. iron in one minute.

Crompton Motors.—As most of the supply companies in London have recently made big reductions in prices charged for current for power purposes, there has been a tremendous increase in the demand for motors of the smaller size. Feeling the importance of this demand, Messrs. CROMPTON AND CO., LTD., made a special exhibit of their continuous and alternating current motors, these being shown in all sizes and both types, from ¼h.p. upwards. Among the other exhibits was a 30h.p. single phase motor, driving a protected type dynamo supplying continuous current to several of the motors and arc lamps on the stand.



CROMPTON ELECTRO-MOTOR, WITH CASE SHOWN OPEN.

Single Phase Lift Motors.—An interesting exhibit was a single phase lift motor of the reactance type, designed to start against heavy loads with low starting current. The machine is designed to give 10h.p. under ordinary lift conditions, and runs at 750 revolutions per minute. With motors of this description a large starting torque is obtained with a small current consumption, and this makes them particularly suitable for lift and crane work. Some tests at Messrs Crompton's works showed that the motor is



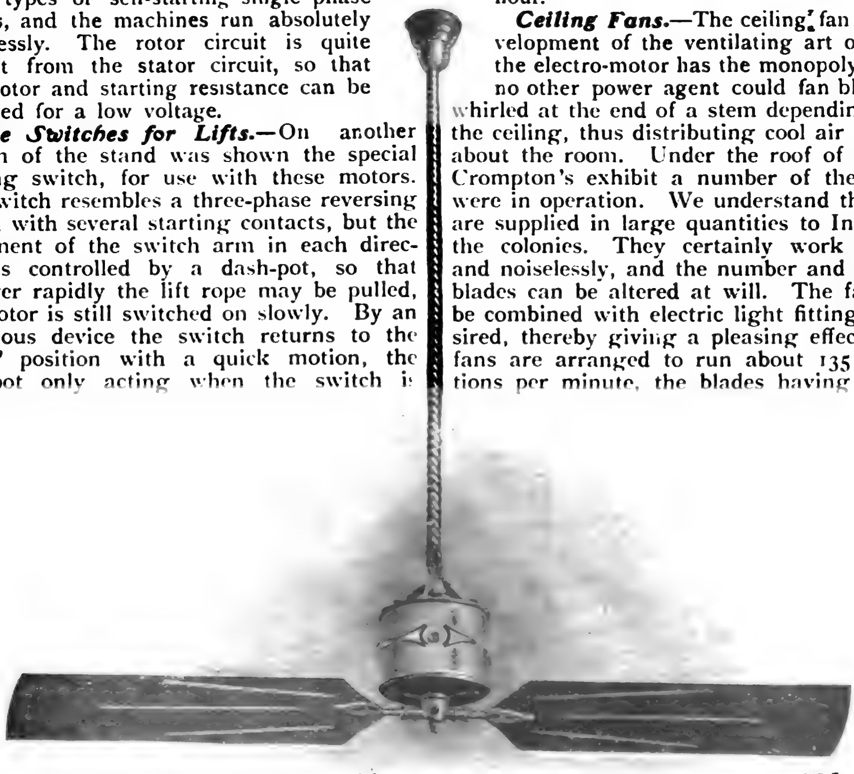
Electric Blowing Outfit, with Direct-coupled Motor.
(Crompton & Co., Ltd.)

capable of exerting 1.75 times the full load torque with only 1.5 times the normal full load current. There is no sensitive or complicated controlling gear, necessary in most other types of self-starting single phase motors, and the machines run absolutely sparklessly. The rotor circuit is quite distinct from the stator circuit, so that both rotor and starting resistance can be arranged for a low voltage.

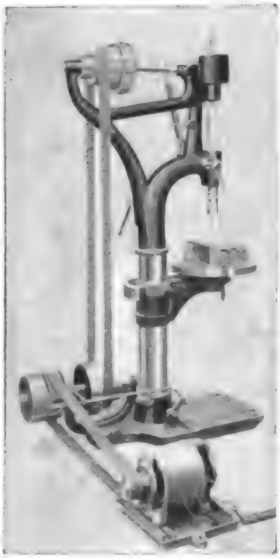
Rope Switches for Lifts.—On another portion of the stand was shown the special starting switch, for use with these motors. The switch resembles a three-phase reversing switch with several starting contacts, but the movement of the switch arm in each direction is controlled by a dash-pot, so that however rapidly the lift rope may be pulled, the motor is still switched on slowly. By an ingenious device the switch returns to the "off" position with a quick motion, the dash-pot only acting when the switch is moving to the full speed position in each direction.

Electric Buffing and Bottling.—The applications of the electro-motor to industrial power machines will seem to the reader of this record to have no end. In the Exhibition were working examples of buffing machines and bottling devices operated by electro-motors. At Messrs. Crompton's stand types of these were shown in motion. The buffing machine is very compact and is of the double-ended type, the motor being designed for an output of 1h.p. and a speed of about 2,000 revolutions per minute. The machine was of the totally enclosed type, with dust-proof glands, and is designed for the heaviest class of buffing work. The bottling machine exhibited was electrically driven, the 1h.p. Crompton motor being an integral part of the bed-plate. When electrically operated the machine will average 120-180 dozens per hour.

Ceiling Fans.—The ceiling fan is a development of the ventilating art of which the electro-motor has the monopoly. With no other power agent could fan blades be whirled at the end of a stem depending from the ceiling, thus distributing cool air streams about the room. Under the roof of Messrs. Crompton's exhibit a number of these fans were in operation. We understand that they are supplied in large quantities to India and the colonies. They certainly work silently and noiselessly, and the number and form of blades can be altered at will. The fans can be combined with electric light fittings if desired, thereby giving a pleasing effect. The fans are arranged to run about 135 revolutions per minute, the blades having a total



Electric Ceiling Fan for Ship, Restaurant, and Hotel Use.
(Crompton and Co., Ltd.)



ELECTRIC MOTOR BELTED TO DRILLING MACHINE. (Crompton and Company.)

sweep of 5ft. The bearings are fitted with dust-proof, self-oiling, and self-adjusting renewable ball races, and the blades are fastened to the carrier in a manner which renders it impossible for them to fly out accidentally.

Motors of all Types.—At the exhibit of MESSRS. SIEMENS BROS. AND CO., LTD., motors of all types were displayed and shown in operation. The Class B. and B.A. machines are standardised for small outputs and are of the bi-polar type. They are manufactured either as enclosed or open machines as required. The F.A. machines are also exceedingly compact, and can be supplied protected, ventilated, enclosed, or fully enclosed.

A TYPICAL ELECTRO-MOTOR BY SIEMENS BROS. AND CO., LTD.

Crane Controllers.—The various motions of a crane can in the case of the electric type be imitated at the controller. For instance, to raise the load the controller lever would be raised and *vice versâ*. Similarly slewing to right and left would be performed by corresponding motions of the controller handle. Messrs. Siemens Bros. have adopted this arrangement in a special line of crane controllers, and in practice it has been found to give highly satisfactory results. The controller is of the drum type, and is actuated by a horizontal arm which gears on to the controller spindle, through rack and pinion motions which give the movements corresponding to those of the crane.

Sewing by Electricity. — The sewing machine motor has been an institution in some clothing establishments for quite a few years, and now in a very compact form it is available for domestic use. The WESTERN ELECTRIC COMPANY, among their exhibits of heavy motors and telephone apparatus, were showing two sewing machines electrically operated. A tiny motor $\frac{1}{30}$h.p., is mounted back of the flywheel, and drives on to its periphery by a friction wheel mounted on the motor shaft. This wheel has a convex face, and by the treadle adjustment can be moved to give different speeds. The motor base contains the starting switch, and this is actuated by a chain attached to the treadle below the sewing table. Pressure on this treadle swings the motor into contact with the driving-wheel and switches on the current. The motor can be swung clear of the sewing machine, which can be treadle-operated in the ordinary way if desired. Of the machines shown in operation one was fitted with a d. c. motor, and the other with an induction motor, the drive in this case being by belt and friction wheel. We understand that the machines proved quite attractive, and a number were sold at the stand. The current required is about $\frac{1}{4}$amp., which is very moderate for the convenience and ease of the machine.

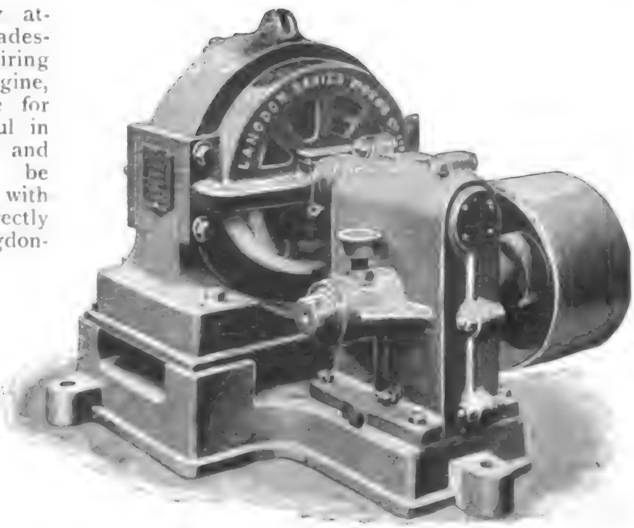
Push Button Lifts.—Lifts and elevators are now indispensable adjuncts of commercial establishments, hotels, &c. After many years devoted to its development and perfection, the electric lift is now a powerful rival of the hydraulic form, and on grounds of greater economy, efficiency, convenience, and appearance, is beating its older competitor from the field. At the stand of MESSRS. SPAGNOLETTI AND COMPANY a model of a Stigler push button lift was shown, with car moving up and down between four floors. The lift is entirely controlled by the passenger, who has only to press a button to bring the lift to his particular floor, and another button

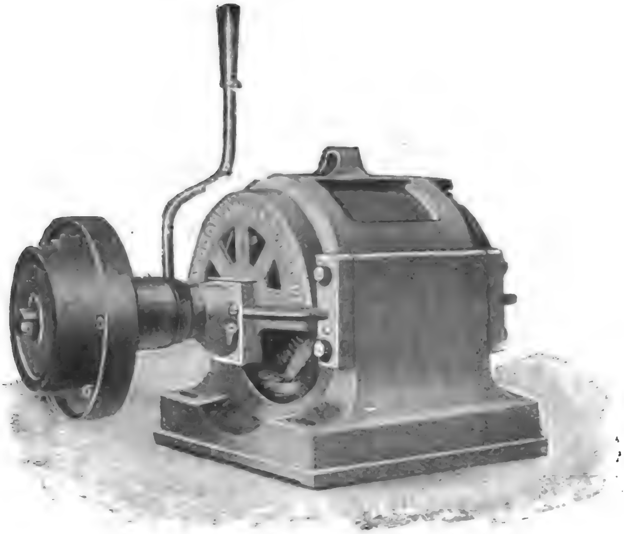
THE EXHIBIT OF SPAGNOLETTI AND COMPANY.

to take him wherever required. Safety devices of every kind are fitted, so that the car, though having no regular attendant, cannot get beyond control. For instance, a start cannot be made unless all the lift well doors are closed. If by any means a door is forced open the car comes at once to a standstill. The car stops at the floor corresponding to the button pressed. There is no fear of shock to the passenger as the circuits are of a low voltage, and no heavy currents are carried by the car wiring. The model was in full working order, and demonstrations were given to interested inquirers. We may mention that lifts of this pattern are in use throughout the country, so that an inspection of some typical provincial installation could be easily arranged for prospective users of such apparatus.

Motor Drive Specialities.—As typifying what can be done with the small motor, the exhibit of the LANGDON-DAVIES MOTOR COMPANY, LTD., was particularly attractive. There are thousands of tradesmen having small machines requiring power who instal a noisy gas engine, frequently disproportionately large for the work to be done and wasteful in transmission of its power by belts and shafting. Great economies can be effected by displacing these engines with electric motors which can be directly applied to their work. The Langdon-Davies Motor Company has installed great numbers of motors of quite small power for driving trade machinery, and in addition to exhibiting motors at Olympia they also showed several motor-driven appliances. A cigarette-making machine and a cardboard-box machine were in operation driven by motors, the drive being of the simplest and most silent kind.

Electric Organ Blowing.—The hydraulic and gas organ blowers are gradually becoming things of the past. Electric power is so much more convenient, and gives a wider range of pressures; in addition it is more reliable and economical. At the Langdon-Davies stand a kinetic organ blower was on view, which proved a great attraction to clergymen and organ-builders. The blower was in active operation, and gave ample evidence of its efficiency. It may be said that the arrangement of motor and blower ensures the minimum of space occupied; a desideratum in a cramped organ loft. The


ALTERNATE CURRENT MOTOR AND REDUCING GEAR FOR BELT DRIVE.
(Langdon-Davies)



One Phase Motor with Friction Clutch. (Langdon-Davies.)

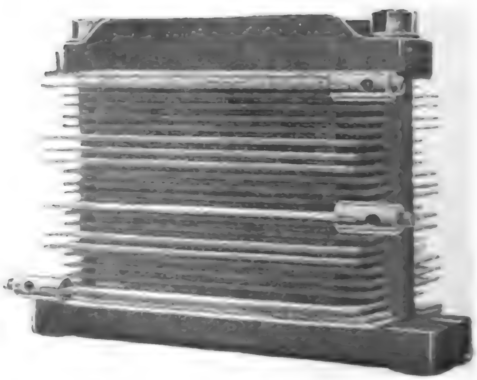
blower exhibited was fitted with a new automatic starter, which requires only one action of the switch instead of two as formerly. The feature of this class of blower is that no bellows are used, and the wearing parts are reduced to two bearings, which need little attention. The supply of air is automatically regulated by the demands of the organ, and the entire apparatus can be completely controlled from the keyboard.

Electric Brewing.—As an instance of one of the Langdon-Davies Company's installations we may mention a large brewery at Dartford, Kent, in which motors replaced a steam power plant. The brewery is fitted with what is technically known as a 30 quarter plant, and sixteen motors have been fixed to drive the machinery. The machines include a 7cwt. barrel hoist, a 7cwt. hop and sugar hoist, mash tun rakes, a malt mill, barley cleaners, dust destroyers, &c. With steam driving the cost was about £395 during six months of 1904, and during the same period of 1905 it amounted to about £250. Installations of this kind should always be inspected by those contemplating the introduction of electric power, and when figures are available they will generally be found to justify the change from either steam, oil, or gas. The installation above mentioned was equipped with Langdon-Davies direct current motors, this type of motor being now built by the company at its own works.

Reyrolle Starters.—The motor starters exhibited by Messrs. A. Reyrolle and Co., Ltd., possess features quite peculiar to themselves and certainly unique. A badly-designed starter is the *bête noire* of electric power users, and unless the device is constructed to withstand rough usage it does not long survive in practice. A good motor starter is quite indifferent to the treatment it receives, and will outlive the motor itself in many cases. The Reyrolle starter is fitted with a resistance unit which is practically indestructible, and which has a "valve" effect of passing only sufficient current to start the motor.

Wait at the first stop.—In practical use the Reyrolle starter requires that when starting the motor the switch arm be held on the first stop until the motor commences to turn. The coherer effect of the resistance allows enough current to pass to the motor to start it, and it will do this against full load. A practical demonstration of this feature was given at the stand, and a motor with brake on, and weights equivalent to full load, started gradually and without shock until full speed was attained. An ammeter indicated the very gradual rise of the current, and further it was impossible for the motor to be damaged even if the starter was thrown over. Again, the resistance can be brought to a red heat for a short time without damage to itself. Fusion of the resistance cannot occur, nor can the parts oxidise or otherwise deteriorate. We understand that Messrs. Reyrolle are prepared to supply any stock size of starter on three months' trial as a motor starter.

Drum Controllers.—The drum type of starter and controller is much favoured for heavy duties, and Messrs. Reyrolle have standardised a line of this pattern which is widely used on the Tyneside. From the experience gained by its employment, almost



Indestructible Resistance Unit. (Reyrolle.)

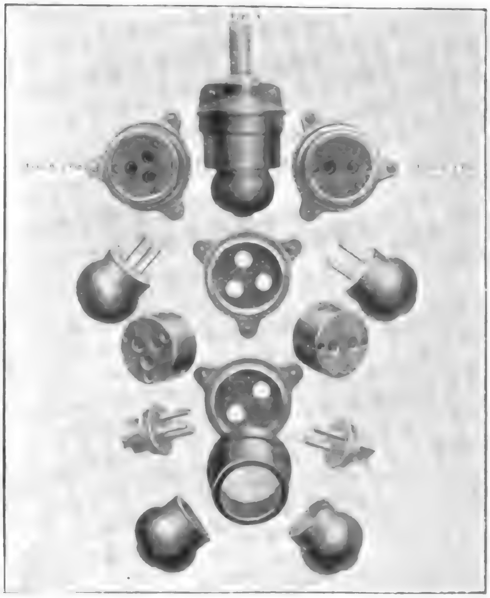
at the door of the works, many improvements have been introduced, and a highly efficient device is now the result. For shipyards, cranes, hoists, and in fact all exposed situations it is both durable and reliable, and also it is completely weather proof. The terminals are mounted on porcelain, and a double-pole switch is combined with the starter. By an interlocking attachment the starter handle cannot be left in an intermediate position, and similarly the armature circuit cannot be closed with an open field circuit. With the addition of two single-pole fuses, the apparatus can be made quite self-contained, and no further switches or fuses will be needed for connecting the motor to the supply mains.

Cast-iron Wall Plugs.—Users of wall plugs for portable motors will be familiar with breakages which occur when porcelain or wood is used in their construction.

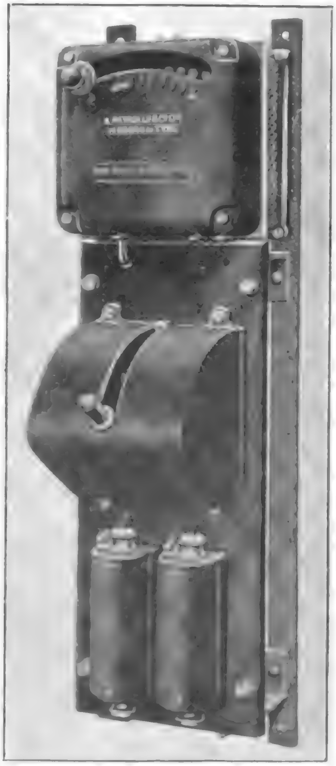
TYPICAL MOTOR STARTER AND RESISTANCE. (Reyrolle.)

Messrs. Reyrolle exhibited specimens of their substantial wall plugs and sockets, the live parts being embedded in insulating material surrounded by cast-iron cases. They cannot be short circuited, nor can a shock be received from them, so that they are specially suitable for workshops, shipyards, boiler works, tramway car-sheds, &c. The construction will be clear from the illustration, and the plugs are suitable for all pressures up to 500 volts. The two-pin and three-pin sizes are guaranteed to break up to 10 amperes without injury to the contacts.

Starting Panels.—A complete panel, fitted with motor-starting switches, fuses, &c., is often needed for moderate-sized motors. Such panels need only be erected on a wall and connected up to be of immediate service. Delays in fusing separate pieces



CAST IRON WALL PLUG, SHOWN ASSEMBLED AND DISSECTED. (Reyrolle.)

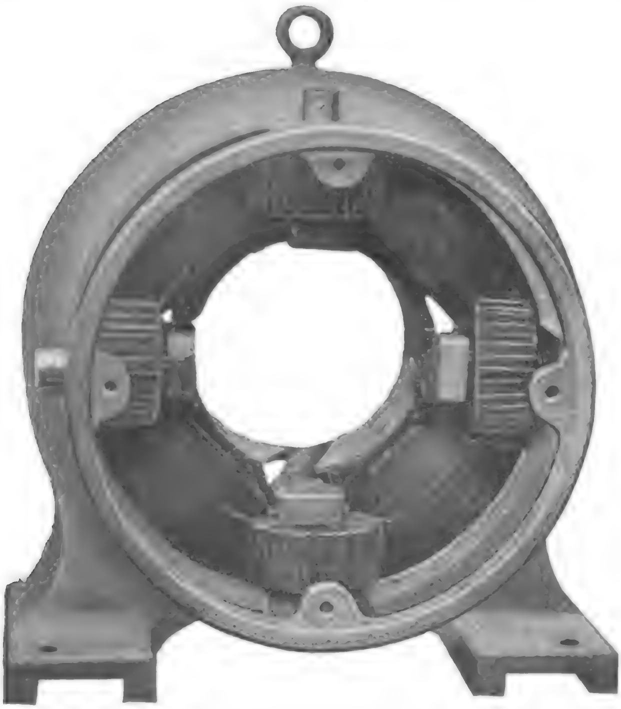


COMPACT MOTOR STARTING PANEL, WITH MAIN SWITCH STARTER, AND FUSES. (Reyrolle.)

of apparatus are also avoided. Messrs. Reyrolle have recently introduced a compact motor-starting panel fitted with d. p. switch, two s. p. ironclad fuses and a protected starter with overload and no volt release. The parts are mounted on a slate base, and the whole makes a good sound job for a compact motor switchgear. A large number are in use on the mains of Newcastle-upon-Tyne electric supply for motors up to 10 horse-power.

Multi-Speeds for Motors.—Unlike the gas engine, the electro-motor has a very wide range of speeds at which it can be operated. This entails no external speed cones and pulleys, but is an inherent feature of the motor itself. To users of machine tools and appliances requiring a constant variation of speed the electro-motor is the ideal power agent, and wherever electrical energy is available should be adopted without hesitation. The largest and finest workshops throughout the world are now equipped with electrically-operated tools, and without the justification of economy, reliability, and efficiency they would never have been given such duty. In the matter of motors for tool service, the exhibit of the MORRIS-HAWKINS ELECTRICAL COMPANY was highly interesting. The company are motor specialists, and consequently put the best into their designs and manufactures. A special feature of the motors shown was the new commutating magnet by which a great speed variation is made possible and heavy overloads can be withstood without injury or sparking. The application of the commutating magnets is of course not a new one, but the design of the particular magnet adopted by the Morris-Hawkins Electrical Co., Ltd., appears to have many good points. The pole core of the commutating magnet is circular in section, thereby economising in copper and in the consumption of energy. In order to take advantage of the circular section the magnets are mounted outside the common symmetry plane of the main magnets. The design being of simple construction, it is cheap to manufacture and especially adapted for the line of standard motors manufactured by the company. The chief advantage of this design of commutating magnet is its extreme simplicity and its small cost of manufacture, while the current absorbed in its excitation is very small.

THE MORRIS-HAWKINS AUXILIARY POLE AND COIL



MOTOR FITTED WITH SPECIAL COMMUTATING POLES. Morris-Hawkins.)

Electric Planers.—A test on a 35b.h.p. motor made by the Morris-Hawkins Company and supplied to Messrs. Hulse and Co., of Salford, for driving a planing machine showed remarkable results. The motor is wound for 400 volts, run at 760 revolutions per minute, and at the time of the test there was a 10 ton object on the table, although the motor at different times dealt with an object weighing 17 tons.

The following are the principal dimensions of the planing machine in question :

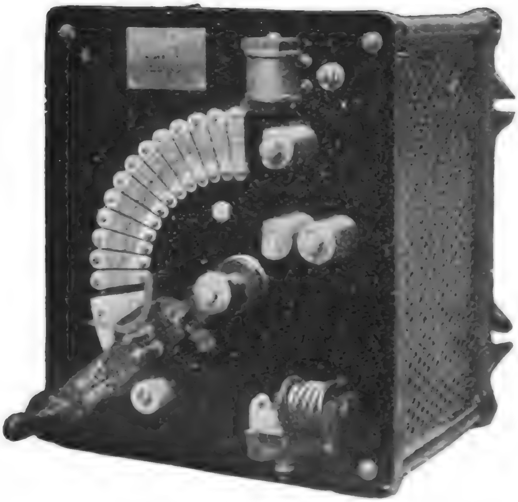
Length of table	28ft.
Weight of table	14 tons.
Width of table	7ft.
Travelling speed cutting	20ft.
Travelling speed backing	45ft.
Max. weight of job	20 tons.

The motor dealt with this overload, which reached about 80 per cent. above the normal rating and with a complete absence of sparking, with the brushes fixed in the geometrical neutral position. The application of the commutating magnet as described refers to a motor running at constant speed and in one direction of rotation, but they have of course as great a value for reversible motors and for motors where speed variation is required.

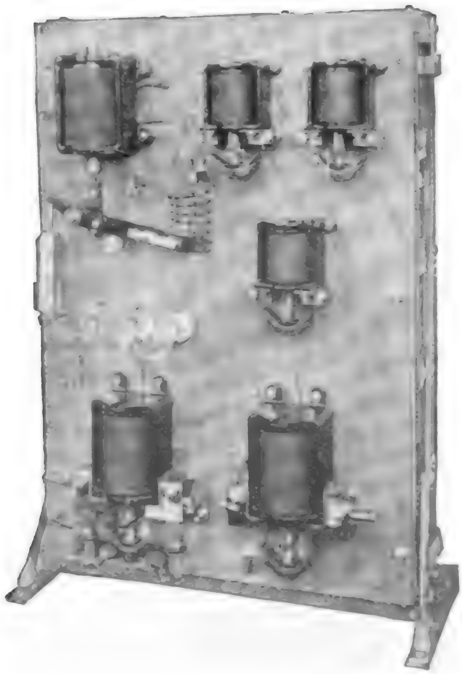
A New Speed Motor.—With regard to variable speed motors, the Morris-Hawkins Company are of course fitting their patent magnets on all 500 volt machines. They have in addition developed a new method of speed regulation which is independent of the weakening of the field by shunt control. The speed variation of this patent motor is effected by altering mechanically the reluctance of the magnetic circuits of the motor. A revolution of a hand-wheel effects the necessary regulation, and a reliable and efficient method of speed variation is thus obtained. The variable speed motor does not require any separate electrical apparatus for its operation beyond the ordinary starting switch. The motor exhibited had an output of 7h.p. at 350 to 950 revolutions per minute, and was shown in operation.

"Igranic" Starters.—The "pet" name attaching to any commercial device quite frequently passes into proverbial use after a period of publicity for the particular article has elapsed. "Igranic" is not the name of a new tea or any comestible, but just a good plain motor starter. The STURTEVANT ENGINEERING COMPANY displayed a comprehensive collection of their motor starting and controlling switches at Olympia which would do the eyes of power companies and consumers good to see. The chief admonition of the Sturtevant Company to motor-starter buyers is to see that the name "Igranic," like other famous names, is on each piece of apparatus. We need only say, with regard to the "Igranic" rheostats and starters, that they are being very widely used, and are proving highly satisfactory in every way.

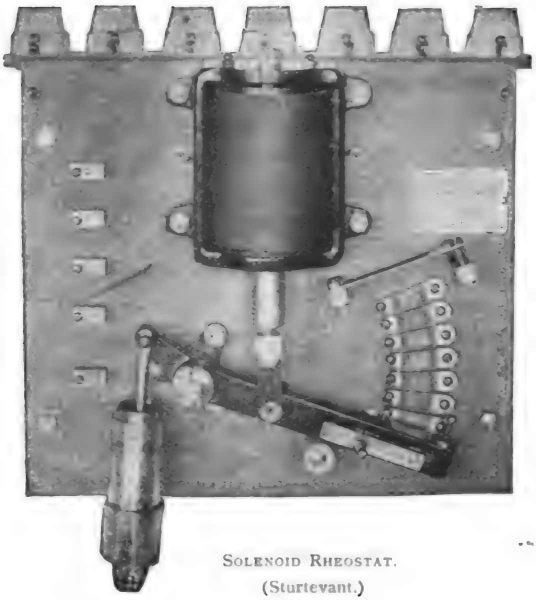
Electric Lift Controllers.—The easy starting and stopping of an electric lift are amongst its many noticeable features—noticeable to the passenger, we mean, and he, after all, is the person to consider. This absence of jar and jerk is due entirely to the efficient controllers now made for elevators of this kind. The Sturtevant Engineering Company are experts in matters appertaining to lift control, and make car-switch or rope-operated controllers. The car-switch controller is a neat device which gives the attendant electrical control over the starting gear. The control switch proper is actuated by the opening and closing of light circuits which bring solenoid switches into action, and ensures steady starting and stopping of the lift. With the rope-operated controller the switchgear is mounted complete on a single support, which occupies a minimum of space. The pulling up or down of the rope starts the car up or down as desired, the motor in each case being gradually started and stopped. Lifts of this kind can be operated from the supply mains of the local electricity works, and are, of course, always available day and night.



"IGRANIC" MOTOR STARTING SWITCH, WITH OVERLOAD AND NO LOAD CUT-OUT. (Sturtevant.)



COMPLETE BOARD FOR AUTOMATIC CONTROL OF LIFTS. (Sturtevant.)



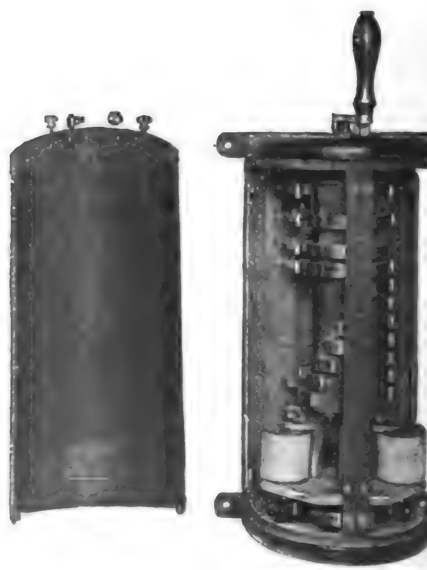
SOLENOID RHEOSTAT.
(Sturtevant.)

Machine Tool Starters. — A variety of speeds is generally needed with electrically driven machine tools, and these are best obtained on the motor itself rather than by complicated speed reducing devices. A properly designed motor and a good regulating switch will admit of speed variations of 4 to 1 being obtained. The Sturtevant Engineering Company have made a special study of motor starters and regulators for heavy and light machine tools, and standard types are manufactured for both duties. These are the drum and slate front patterns respectively, and they can be supplied for reversing or non-reversing motors as desired.

Handy Electric Drills.—Electro-motors, when adapted for drilling work, make up an ideal tool, which is both handy, light, and efficient. They can be carried about with ease, and where electrical energy is available can be operated at almost any distance from the supply source. Lengths of flexible cable convey the current to the tool, and there is no danger either of fire or of shock. The CONSOLIDATED PNEUMATIC TOOL CO., LTD., specialise in portable electric drills, and they exhibited a standard range for both heavy and light work. A new type contains a magnetic drill pillar, which firmly holds to the base when of iron or steel. This device consumes only 50 watts, and it adds greatly to the utility of the portable electric drill. Tools of this kind can be used in any ordinary workshop adjacent to the supply mains, and we understand that upwards of 500 ½in. holes can be drilled in a 1in. steel plate for a consumption of only a pennyworth of electricity. Small manufacturers should lose no opportunity of employing these handy tools in their shops.

Motor Starters and Regulators.—In addition to the usual starting device for a motor, it is frequently necessary to provide means of regulating the speed at which the motor shall run. This involves no complicated mechanical devices, but merely the addition of a few contact studs and resistance grids in the starter case. MESSRS. GEIPEL AND LANGE exhibited what they term a fool-proof motor starter which prevents too rapid cutting out of the resistance. This starter is fitted with a regulating arm for inserting resistance into the field circuit. The arm is independent of the ordinary starting lever, and will remain in any desired position. Should the overload or no voltage release be operated, however, the regulator arm is moved back to the full field position; consequently when the motor is again started the field is given its maximum value and damage to the motor will be avoided. All the contacts are renewable, and each part of the starter can be renewed from the front.

Automatic Motor Starters.—Since the perfection of the hand-operated motor starter attention has been turned to the employment of electrical energy for operating the various starting devices. In special cases, such as for pumping into tanks, organ blowing, and electric lifts, the solenoid switch and rheostat is a necessity, and contributes largely to the success of such electrically-operated devices. Messrs. Geipel and Lange were exhibiting a complete range of their specialities in this



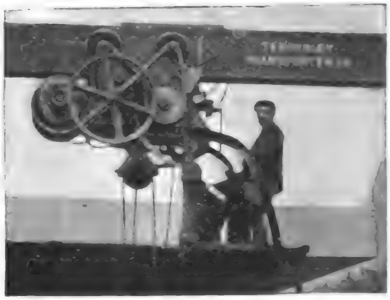
DRUM TYPE OF CONTROLLER.
(Sturtevant.)

direction, several devices being shown in operation. A feature of their auto-starting panels is a magnet switch which closes the main motor circuit before the exciting solenoid rheostat which cuts out the armature resistance and speeds up the motor. There is a variety of purposes to which these magnet switches and rheostats can be put, and their field of utility is by no means covered. When the possibilities of the idea are more fully realised new adaptations will be found. Where motors are needed for intermittent services, but an attendant is not necessary, the use of a time switch in conjunction with solenoid switches will work wonders. The combination can almost be made to think.

Electric Coal Transporting.—For the operation of transporting machinery such as is now commonly used for coal, grain, flour, earth, &c., the electro-motor is unrivalled. Its capabilities in this province have been proved over and over again, and if further evidences of its superiority to other powers were required they were available at the exhibit of the Temperley Transporter Company. Some four models of Temperley devices were shown in operation, proving a constant source of attraction during the Exhibition. A fixed transporter with Temperley grabs as used in a number of electricity works was shown in operation. The model was a complete replica of the full-sized plant, both as regards the transporter and the operating and controlling gear. Lifting, lowering, opening and closing the grab are operations performed by means of a double drum winch. For traversing the traveller along the beam a separate winch is used and the hoisting winch has special compensating gear which enables all the operations to be carried on separately or together without interference. This is a valuable feature, as transporting can be commenced as soon as the load is lifted clear of the hatchway coamings. Similarly at the dumping end the grab can be lowered to its discharging level before the transporting motion is completed. In reality the grab motion is represented by a curve in a vertical plane from one point to the other. The grab is of the two-rope type and can be opened and closed in any position, and at any time the operator may wish. It can, for instance, be lowered through a hatchway while closed, and opened before reaching the coal. In this way it can be worked close to the vessel's hold and damage to hatchways is avoided. The grabs are made to lift from 12cwt. to 5 tons or more at a time. Duties of from 20 tons to upwards

Exhibit of the Temperley Transporter Company.

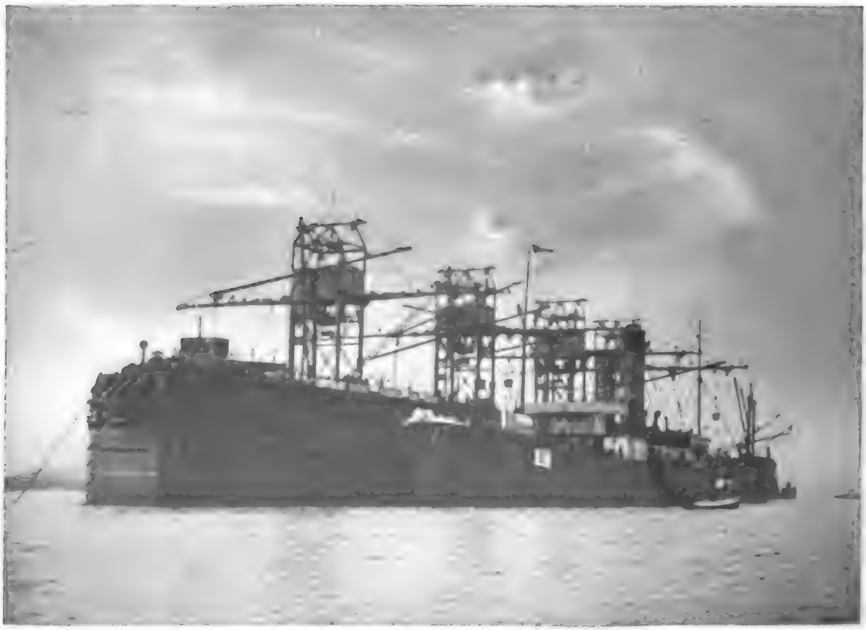
TEMPERLEY TRAVELLING TOWER TRANSPORTER.



TEMPERLEY ELECTRIC TRAVELLING GIRDER HOIST.

of 200 tons per hour can be obtained from one transporter according to the power of the motors and winches employed.

Travelling Tower Transporters.—A working model of a Temperley travelling tower transporter was also shown in operation. With this type of transporter the beam is supported by a single tower running on wheels. This tower contains the winches and motors, also the controlling gear for performing all the transporting operations. The towers are sufficiently stable to operate without chocks or rail clips, and this allows of their travelling when the load is at the extreme end of the beam. This pattern of transporter is fitted with a patent automatic skip and fall block which allows of the coal being lowered close to the stock heap for dumping. This prevents breakage of the fuel. The standard transporter is fitted with travelling gear and can be arranged for any desired over-reach up to 100ft. A rectangular stock heap of any length and depth and about 200ft. wide can therefore be formed. One man only is required for all the functions of the transporter, and the cost of working is a minimum as no machinery is ever running idle. The wearing parts are few in number, being practically confined to the traveller wheels and the steel wire lifting rope. A working model of a Temperley patent portable transporter was also on view as well as a Temperley patent traveller to lift and carry gross loads of 35cwt.



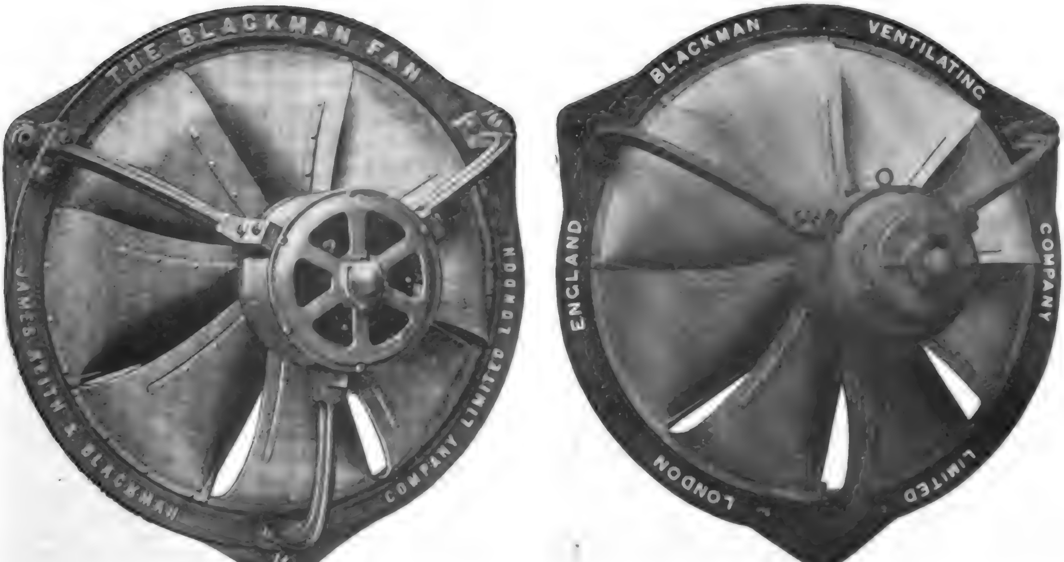
TEMPERLEY 12,000 TON FLOATING COAL DEPÔT.
This coaling ship carries 12,000 tons of coal and is the largest in the world. It was designed and equipped by the Temperley Transporter Company. All the machinery is operated by electric power, which is generated on board the vessel.)

Electrical Ventilating.—There is no excuse in these progressive times for poor ventilation in buildings of any description. Proper ventilation is only secured by extracting the air at a point near the roof or ceiling. Electric fans are now marketed which make ventilation a simple and economical business. One needs but to cut a hole in the wall and cover the aperture with an electric fan. Blackman fans are standardised for use with single multiphase and continuous current motors, and are constructed on scientific principles. The motor is mounted directly on the fan spindle and can be started from any desired position. In cases where the air moved is charged with dust or steam a completely enclosed motor is employed.

High Pressure Electric Blowing.—The Keith-Blackman combined blower and motor system is also applied to larger sizes, and blowers are standardised with outlets ranging from two inches up to twelve inches in diameter. The KEITH-BLACKMAN exhibit proved a great attraction, and the various examples of the company's fans and blowers were inspected with great interest. We are given to understand that any special requirements can be met by the company, who are specialists in this particular branch of work.

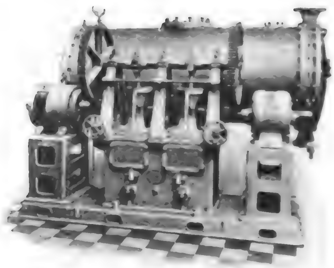
Keith-Blackman Fans.—Since its introduction the electro-motor has revolutionised the art of creating draughts. Whether for cooling an office or ventilating an enormous works, the electric fan stands to-day as the most efficient machine of its kind. The earlier fans were operated by belts, and the desire to economise space resulted in the production of a more compact unit in which motor and fan were directly coupled. With the Keith-Blackman system compression has been carried still further, and motor and fan are now integrally associated. The motor carcase and the blower case are cast in one, resulting in a remarkably compact unit. A device of this kind has been developed for blowing smiths' fires, organs, &c. With the present system of arranging a smith's shop, one blower is usually provided for all the fires. This is not conducive to economy, as pipe losses have to be reckoned with, and the blast must be continually on. The Keith-Blackman combined motor and blower can be fitted direct to the tuyeres of each forge, and considerable economy is effected thereby. The power required is small, 100 watts for light and 300 watts for heavy work, and 33 to 50 per cent. of the energy required for a single large blower can be saved. Each motor has its own controlling switch, and every fire is independent; consequently repairs can be made without stopping the entire smithy. A total saving of from 50 to 70 per cent. of power is possible, and, assuming the first cost to be rather above that of a single blower, the outlay would soon be recovered by the greater economy.

Electric Pumps.—That motors will withstand constantly the jars and shocks of pumping has been proved up to the hilt in practice. To all known types of power pumps the electro-motor can be applied, and in the



KEITH-BLACKMAN FANS, DRIVEN BY ELECTRO-MOTORS.
The left and right-hand fans are operated by alternating and continuous current motors respectively.

most recent patterns of slow speed machines gearing is not needed. The examples of motor-driven pumps adjoining depict the use of gearing to give the desired speed at the pumps, and the combination is a highly efficient one. Pumps are frequently needed in tall commercial buildings to maintain the water pressure at the upper floors, and in this field the electric pump renders good service. Its silent and smooth running is largely responsible for its adoption in places where other forms of drive could not be tolerated. A steam pump, for instance, with its attendant boiler, is undesirable, and a gas or oil engine under the same circumstances would, by reason of the noise, be equally so Again, on the score of attention the electrically driven pump scores at all points, as it can be controlled entirely by the water level in a tank or by the pressure in an accumulator. It can also be started and stopped from the caretaker's rooms if desired.



CONDENSER & AIR PUMPS

BRUSH MOTORS DRIVING TWO-THROW AIR PUMPS.

The exhibit of the Brush Company gave ample evidence of the adaptability of motor driving in this province and of the problems solved in connection with it.

Brush Motors.—By the use of specialised machinery and by adopting a design which admits of quick production without sacrifice of efficiency or reliability, electro-motors can now be produced at prices far below those once obtaining. These circumstances are at once favourable to the user of such machines, and have placed at his disposal the best designs embodied in practice in the best possible apparatus. The direct current motors of the BRUSH ELECTRICAL ENGINEERING CO., LTD., are designed on standard lines with the greatest attention to details, and they have proved in practice to be substantial and durable machines

A feature of the motors is the commutator, which is generously proportioned and will admit of long periods of wear on that account. Again, all parts are made strictly to jig and are therefore interchangeable. This is important where spare parts are kept and when replacements are ordered from the works, as no trouble is encountered in effecting the repair. Motors are constructed from ¼h.p. upwards, and any large size can be supplied for special requirements.

Induction Motors.—Where alternating currents are supplied from the local electricity works induction motors are used for power purposes. They have the advantage of requiring

KEITH-BLACKMAN COMBINED MOTOR AND BLOWER APPLIED TO A SMITHY.

no commutator or brushes, and are much simpler in their general construction. This simplicity is a safeguard against breakdowns, and it conveys immunity from damage in cases of flooding. Some induction motors have been submerged for considerable periods but have subsequently been dried out without removal from their foundations and put to work again without loss of time. The induction motors exhibited by the Brush Electrical Engineering Co., Ltd., are made in standard sizes from 3 to 60b.h.p., and larger outputs can also be dealt with. The adjoining illustrations depict a complete motor and the stator or fixed element. There are only two bearings, which are self-lubricating, and the machines will run constantly without attention. The larger sizes are fitted with slip rings and substantial carbon brush gear as the starting current is too heavy to admit of the motor being switched directly on to the line.

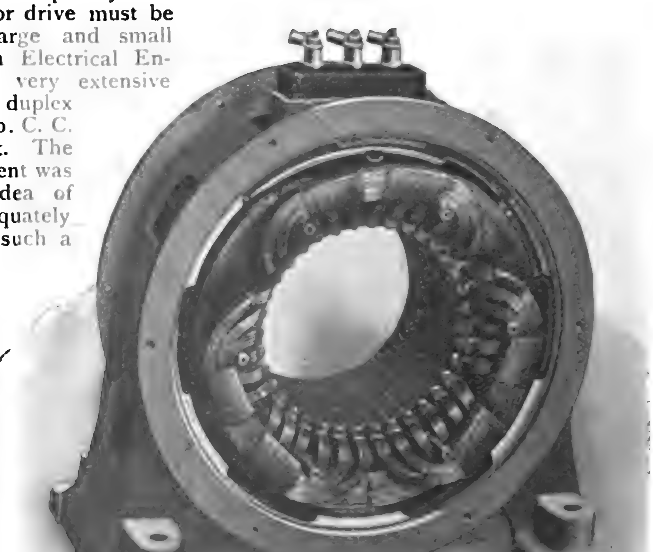
A Motor for Each Tool.—The electro-motor has taught the user of machine tools, whether in large or small shops, that the best method of

Brush Motor Geared to Double-Throw Ram Pumps.

View of Complete Induction Motor. (Brush.)

its employment is a motor for each tool or pair of tools. A humble workshop can ill afford to throw away power in shafting, and with steam or gas engine drive this must inevitably result. Neither gas nor steam engine can be made small and efficient enough to be adapted to each power-consuming device; consequently the lesson of the individual motor drive must be pressed home upon both large and small users of power. The Brush Electrical Engineering Company in their very extensive exhibit showed in operation a duplex boring mill with a pair of 6h.p. C. C. motors driving the mills by belt. The compactness of the arrangement was at once evident, and the idea of individual drive was adequately conveyed. An inspection of such a tool, or any other motor-operated device, immediately gave rise to thoughts of what might be done in other ways by similar means. The duplex mill referred to is a speciality of Webster and Burnett, tool makers, Coventry, and a great variety of work can be turned out on it. One man can attend to the two tables, and keep both constantly at work.

Electrically - driven Planers. — Heavy planing machines for engineering shops have a poor name as tools for the efficient and speedy removal of metal, chiefly on account of the method employed to drive the machine. Belts have hitherto been almost generally employed, and therein the principal causes of inefficiency have lain. Even with electromotor drive the belt has remained an objectionable adjunct, and the maximum economy has not been possible on that account. Vickers, Sons, and Maxim, Ltd., at their stand in the Exhibition, had installed a large planing machine fitted with their new system of motor driving, from which a number of the old-time drawbacks have been removed. There are no driving pulleys to reverse or belts to wear, and it is claimed that the speed of cutting can be instantly varied between the slowest cut and quick return. Reversal is more positive and quicker, and the tool will plane accurately up to a line. The equipment comprises a variable speed shunt motor and special switches mounted on the planer and worked from the driving gear. Where new planing machines are being installed much space can be saved by adopting the Vickers system, but existing machines can be converted without difficulty. The speed variations of the motor are controlled entirely by the shunt current, and its efficiency at all loads never falls below 87 per cent. The planer motor has a speed range from 300 to 900 revolutions per minute, either spur or worm gear being used for the drive. As shown in operation at Olympia the system is simplicity itself, and



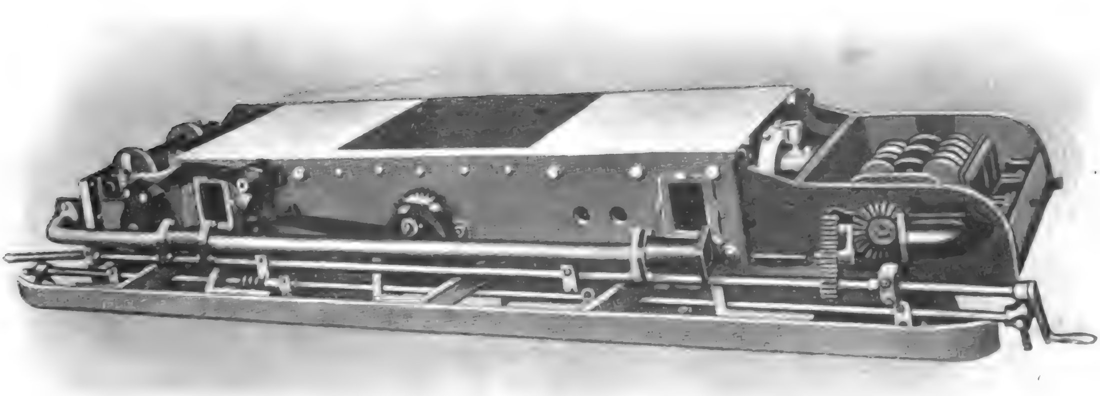
The Stationary Element of an Induction Motor. (Brush.)

it needs no other recommendation, as that simplicity is a guarantee of efficiency.

Coal Cutting.—A notable exhibit by the Brush Company was that of the Birtley-Falcon coal cutter, a machine of the disc type operated by two 15h.p. motors. The machine is specially designed to withstand rough usage and it can be operated by one man and a lad with a saving of 50 per cent. in labour. By the use of different diameters of discs, any depth of undercut can be obtained. The disc is placed at the centre of the machine midway between the motors, and this feature permits of cutting in either a forward or backward direction with equal facility. Intermediate shafts are dispensed with in the transmission, a helical gearing being used to drive a mitre pinion engaging with the disc. This reduces the working parts to a minimum, and minimises the possibility of breakdown. A special feed mechanism is employed which allows regulation of the cutting rate from slow to high speed, without stopping the machine. A hauling gear is fitted for travelling purposes, this being actuated from the motor system. All motors, gearing, and connections are entirely enclosed, so that the vital parts are well protected and fit to withstand rough usage.

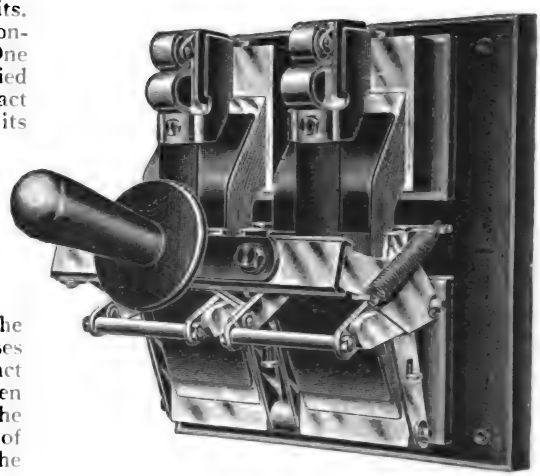
Overload Indicators.—The need of some form of instrument to record an excess current passing through electrical apparatus for more than a short period of time is now fully recognised by central station engineers, insurance companies, and others. This is especially true where motors are sold, let on hire, or insured against damage, with an undertaking to make good defects which may arise during their working, provided a given maximum current has not been exceeded for more than an agreed time. Atkinson's overload indicator has been designed to meet these requirements, and works on the principle of the Atkinson demand indicator. It consists of a horizontal tube containing a metal ball. The tube is pivoted at the centre, and on the same pivot is mounted an iron H armature, suspended between two solenoid coils. Current passing through these coils rotates the armature, tipping the tube, and causing the ball to run from one end to the other. The amount of current required to start the ball moving depends upon the angle at which the tube is set with regard to the armature, and this can be easily varied. The current at which the instrument will record is read on a scale attached to the tube. The time between the overload and its record by the instrument is regulated by a valve, and may be varied from three to thirty or more minutes. The apparatus is made by Engineering Instruments, Ltd., and is very cheap.

Time Limits for Motors.—A cheap and reliable form of time limit device for use with motors has long been needed, and to meet this want Atkinson's patent overload release has been designed. It is suitable for use either with circuit breakers, automatic switches, or motor starting switches. The device was exhibited by MONTÉ-CALLOW AND COMPANY, who are selling agents for Engineering Instruments, Ltd., the makers. While permitting overloads of, say, 25 per cent. to 50 per cent. for periods of time up to sixty minutes, instantaneous release is given with over-



BIRTLEY-FALCON COAL CUTTER, OPERATED BY TWO 15H.P. ELECTRO-MOTORS.
(Brush Electrical Engineering Co., Ltd.)

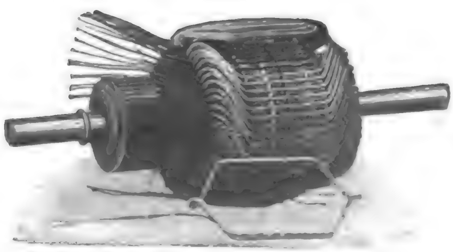
loads of 100 per cent. or short circuits. The release mechanism consists of two contacts in a chamber filled with oil. One contact is fixed, while the other is carried on a flexible support. The movable contact is fitted with a mica vane which damps its movement. At one side of this chamber is a tubular extension carrying a metal ball, free to roll from end to end of the tube. Normally the tube is inclined, so that the ball rests at the end remote from the contact chamber; but when the predetermined load is exceeded, the tube becomes inclined till the ball starts to roll along it. When the ball reaches the contact chamber it presses the flexible contact against the fixed contact and operates the release. The time taken for the ball to roll from end to end of the tube can be adjusted between the limits of three minutes and sixty minutes, while the current at which the ball starts to roll can be set between the limits of 60 per cent. and 100 per cent. of the maximum reading of the ammeter. The instruments may be used for operating circuit breakers either by short circuiting a "hold on" coil, or by operating a relay coil; they may be used for operating motor starters by short circuiting "no volt" release coils. When desired they may be used for ringing a bell to draw attention to the fact that the predetermined load has been exceeded for the predetermined time.



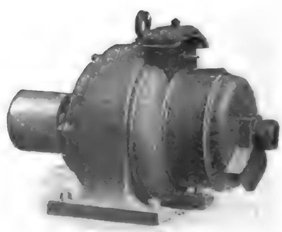
UNION ELECTRIC CIRCUIT-BREAKER FOR HEAVY CURRENTS.

Union Motors.—A prominent feature of the electro-motor is its ability to withstand, in addition to rough usage, extensive overloading without injury. The majority of standard motors at present on the market are equal to overloads of 25 per cent. of full load for one hour and 50 per cent. for short periods. The UNION ELECTRIC CO., LTD., exhibited a standard line of continuous and alternate current motors in which these important overload features are embodied. Their motor designs are based on extensive experience, and the machines are constructed under close supervision, being carefully inspected and tested before leaving the works. We illustrate a complete motor and an armature in process of winding. Prospective users of electro-motors for power purposes, whether in large or small sized machines, should consider their overload properties when effecting comparisons with oil or gas engines. The latter depend largely on speed for the power they exert, and when this falls appreciably so also does the useful work of the engine. A motor, on the contrary, will develop its full power when and as required, and also cope with an overload in accordance to its proportions.

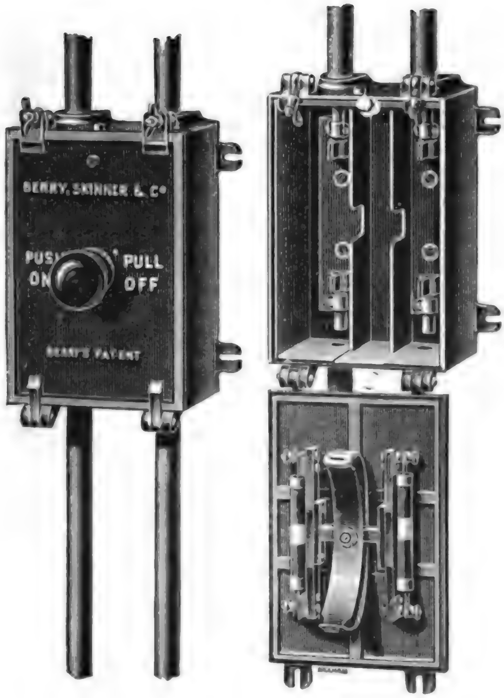
Automatic Regulation.—Yet another unique feature of the electro-motor—it automatically governs its own speed and will never run away. Such dangers as obtain with heavy flywheels on gas engines, presenting risks of bursting, are entirely absent with electro-motors, as their design precludes the rise of speed beyond a certain limit, that limit being a factor in the design of the particular machine. Union motors, in common with other types, share this property, which imparts an element of safety to the use of electric power not obtaining with other power agents. Separate governing devices are always liable to injury or failure, and may lead to serious breakdowns or disasters.



ARMATURE OF UNION ELECTRIC MOTOR SHOWING WINDINGS AND COMMUTATOR.



COMPLETE UNION ELECTRIC MOTOR WITH ENCLOSED BRUSHES AND TERMINALS.



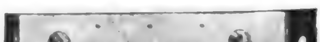
IRON-CLAD D.P. SWITCH FOR MOTOR AND OTHER CIRCUITS.
(Berry, Skinner and Company.)

A Good Main Switch.—The functions of the main switch for a circuit carrying heavy currents resembles that of a valve controlling water, and unless a reliable device is employed at this particular part of the circuit, trouble will invariably follow. The Home Office regulations have done much to improve the design of switches and starters for motor circuits, and are indirectly responsible for the production of a very efficient form which complies almost entirely with requirements. This is illustrated herewith and was exhibited by BERRY, SKINNER AND COMPANY at Olympia. The device is simplicity itself, and as will be seen there is nothing to get out of order. A substantial cast-iron box encloses the working parts, which comprise a carrier or frame, to which fuses and knife contacts are attached, and which is actuated by a knob and spindle passing through a gland in the cover. This cover is hinged, and when pulled down carries with it the parts which complete the circuit, namely the fuses and the carrier. A quick break is assured by the use of a bow spring, which is in compression when the switch is in the "on" position.

Window Model Motors.—Small motors, like those illustrated herewith, have been supplied in large quantities for operating window models of every conceivable kind. To reiterate these would be impossible here, but we

SMALL MODEL ELECTRO-MOTOR.
(Darton and Company.)

may eulogise the motor as an ideal device for this kind of thing. Where accumulators are used they can be charged from the local mains (if continuous current), and the motor will operate for extended periods without charging the cells. The motor can be placed in any position, as there is no danger of fire, nor are there loose levers or flywheels to become entangled in surrounding draperies, &c. Intelligently handled, the model electro-motor is a good investment for tradesmen having window models.



SWITCH PANEL, WITH CARBON CIRCUIT BREAKER.
(Berry, Skinner and Company.)

A Model Electro-motor, suitable for operating window attractions, &c. (Darton and Company.)

Small Motors and Dynamos.—There is undoubtedly a wide field for the sale of model motors and dynamos, and when these devices are well made they are a constant source of delight to the young, and make a reputation for the maker. Cheap and nasty articles of foreign origin have given model dynamos and motors a bad name in some quarters, but the goods of Messrs. Darton and Company are of quite high quality, and superior in every way to those imported and sold for next to nothing. The model motor has a distinct field of utility in certain trades relying on window attractions for custom. Unlike model gas, oil, and hot-air engines, the little motor is quite safe to handle, and simplicity itself to start. Tiny sizes of about $\frac{1}{50}$h.p. can be obtained for operating direct from the supply circuit, but the majority of the models exhibited by Darton and Company were for battery and accumulator use. Types of this class need no description, and a few illustrations will convey all that is needed to explain the design. The smaller machines have contact-breakers instead of commutators, but types fitted with the last-named device are made for battery circuits. More recent patterns are made up in iron-clad form, as well as with vertical spindles, for convenient driving in special cases.

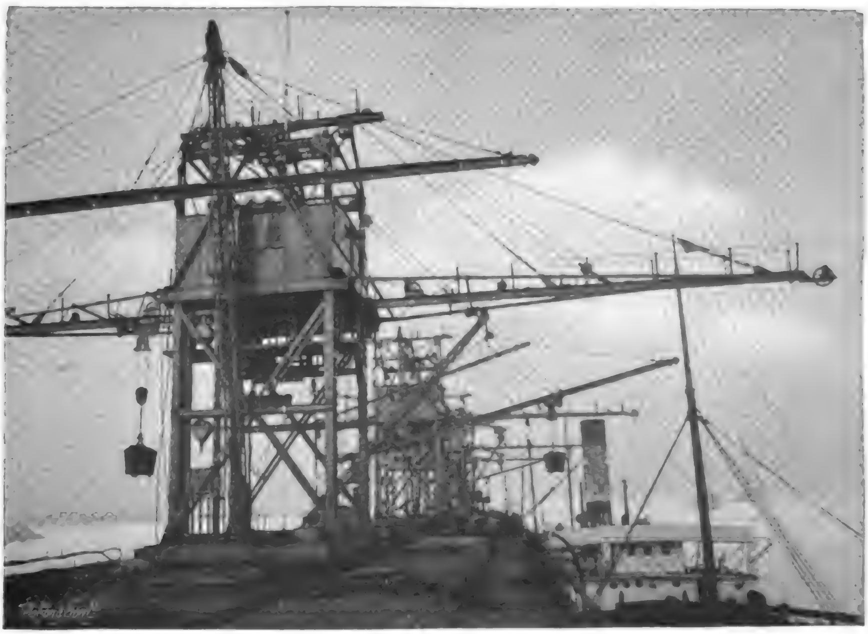
Enclosed Motor Starters. — Damp and dusty, cool and dry situations are alike the same to the electro-motor, as its construction admits of its operating equally well under all conditions of the surrounding atmosphere. In the same manner as motors are enclosed for operating in rooms or other places charged with dust or damp, so also are the starters for such motors enclosed and protected against external air variations. When properly designed, apparatus of this class is highly efficient, and at the same time is very compact. A switch, motor starter, and ammeter can be confined within the limits of a moderate-sized cast-iron box, which, when bolted on a wall, is in no one's way, and is, moreover, completely protected from injury. Again, it is difficult to receive a shock from current-carrying parts, as these are entirely contained within the case. A design of this pattern was exhibited by J. E. Spagnoletti and Co., and is illustrated herewith. The substantial proportions of the apparatus will be at once evident. Included in the case, and under complete cover, are an ammeter, a motor starter, and a d. p. switch and fuse. If desired a push button can be supplied to stop the motor. All operations of starting and stopping are performed without opening the cover.

Enclosed Motor Starter. (Spagnoletti and Co.)

Electrical Machinery Exhibits.

THE Olympia Electrical Exhibition was never intended to be wholly representative of progress in heavy electrical engineering. Had it been so the building could not possibly have contained the many British firms engaged in one or other branch of this important section of the industry. As it was, some dozen firms or more took space to exhibit machinery and apparatus which did not directly appeal to the interests of the general public. These firms, however, displayed commendable foresight in getting their products on view, as a great number of station engineers, directors, and committee men attended the Exhibition and could not fail to be impressed thereby. The purchasing power of these gentlemen is proverbial, and despite the fact that the Exhibition was primarily inaugurated in the interests of prospective consumers of electrical energy, the presence of firms engaged in the production of heavy machinery will have resulted in business, and in many cases good business. While the development of prime movers is proceeding in comparatively easy stages very considerable and important improvements have been made in accessories and apparatus for electricity supply purposes. This applies particularly to coal handling plant, switchgear, pumps, instruments, and machine tools, and representative examples of these were to be seen about the Exhibition.

Coal Handling Plant.—We have referred to the exhibit of the TEMPERLEY TRANSPORTER COMPANY in dealing with motor applications, but in this section we may mention that the apparatus exhibited in model form at the company's stand was typical of the plant usually installed by them for coal handling in both large and small electricity works. The Temperley system has many points to recommend it in preference to either bucket or screw conveyors. It is light and easily erected, and it can be constructed to handle upwards of 200 tons of coal per hour. In large central stations the coal storage problem needs to be approached carefully, and the choice of the machinery for handling the fuel requires close consideration. Although extensive storage is generally



TEMPERLEY ELECTRIC TRAVELLING TOWERS AS USED FOR COALING SHIPS, AND AS APPLICABLE TO COAL HANDLING FOR EVERY PURPOSE.

(34? Temperley portable transporters are used in the British Navy.)

allowed for, where rapid and efficient coal handling plant is installed the speed at which any deficiency in the supply can be made up admits of a smaller stock being kept. With a certain class of coal this has obvious advantages, as deterioration may quickly lower its calorific value and nullify the attempts made to obtain the best results from a given quantity of fuel.

Main Line Electric Traction.—The exhibit of Bruce Peebles and Co., Ltd., contained the only examples of heavy electric traction apparatus at Olympia. For the first two weeks of the Exhibition the company's exhibit comprised large and handsomely-framed photographs of their plant, works, and installations. Subsequently a quantity of dynamo electric machinery was put on view, among this being examples of railway motors, to which we have referred.

The most notable exhibit was the new single phase traction motor which is the joint invention of Messrs. Bruce Peebles, Mr. la Cour, chief engineer to the firm, and Professor Arnold. As will be seen from the four diagrams reproduced, the motor is a development and improvement from the now well-known Latour single phase motor. The motor is of the compensated repulsion type. Referring to diagram A, which shows a Latour motor, it will be seen that there are four brushes for a bi-polar arrangement. By short circuiting the brushes A and B the stator resistance is reduced, and a short circuit current flows, which by action with the field in direction C D produced by the main current gives a torque. When the rotor runs in the field C D, called a cross-field, a back E.M.F. is produced in direction A B. This back E.M.F. multiplied by the current represents the output. The stator winding S, though shown in the diagram as a single coil, is in practice a distributed winding. To reduce the complication of brush gear, &c., Messrs. Bruce Peebles have patented the arrangement shown in diagram B, which produces precisely the same effects as the former arrangement, but with three brushes only instead of four. The arrangement shown in Fig. C, which is also patented, allows the speed to be varied within wide limits, by strengthening or weakening the cross field. No series resistances are then used at starting.

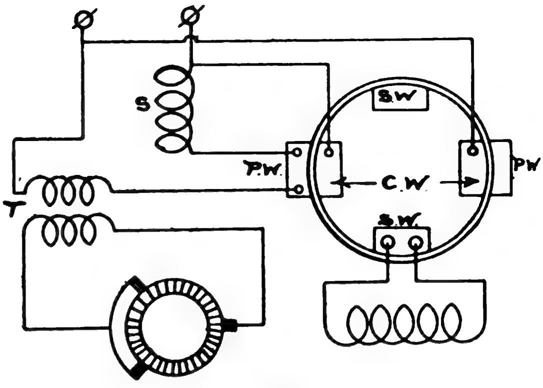


Diagram D. One Phase Motor System, with Induction Regulator.

The diagram D shows a further development of the system—an induction regulator being used in this instance for the control of the cross field, while the stator winding is carried out on the high tension principle; the transformer (T) allowing the commutator to be fed with current at a low voltage. The cross winding is regulated by the position of the secondary winding (S W) of the induction regulator, and the short-circuited compensating winding (C W) on the induction regulator serves the purpose of annulling the self-induction in the primary of the regulator —so that only the ohmic losses in the same need be taken into account. Were this compensating winding not in use, it would be evident that in certain positions the primary winding of the induction regulator would simply operate as a choking coil, as is the case with the primary winding of an ordinary

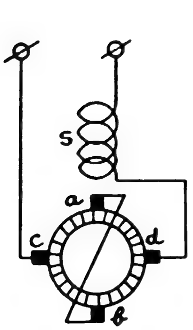
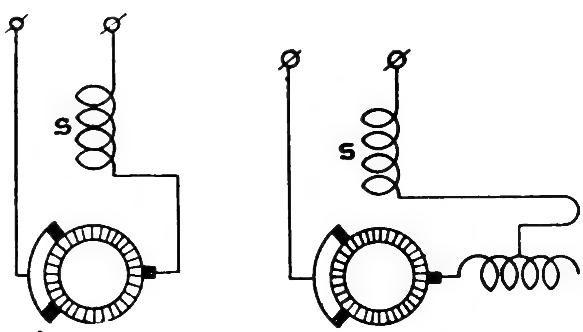


Diagram A.
Latour One Phase Motor.



Diagrams B and C.
Bruce Peebles, La Cour, Arnold One Phase Motor.

transformer when the secondary circuit is open. The effect of the very complete system of compensation for reactance both in motor and regulator is that a power factor of practically unity is obtained over a wide range of speeds and loads. The bearing of this fact on the efficiency of the system cannot be too strongly insisted upon.

Another interesting equipment shown on the stand included two 135h.p. duplex motors, of the P.P.P. patent type, mounted on a heavy railway truck, and constructed by Messrs. Bruce Peebles for the South-Western Traction Company of Canada. These duplex motors are of a very interesting design, as they are constructed to operate either upon 1,000 volts three phase or upon 500 volts continuous current.

Economisers. — Any electrical exhibition would be incomplete without a Green's patent fuel economiser. One of these was erected complete on the stand, containing forty-eight tubes, and presenting approximately 500sq. ft. of heating surface. The scraping gear was shown in motion direct driven by a 1h.p. motor. On the same stand was exhibited a Green's patent air heater, an apparatus which utilises the waste heat from flue gases for supplying hot air to drying rooms for certain manufacturing processes in which moisture must be speedily removed from the material. In conjunction with the heater an 18in. " Clinker " fan was operating, forcing the cold air through the apparatus. This fan was driven by a motor by Electromotors, Ltd. Coupled to the economiser on the stand was a direct-acting Wakefield steam pump used to illustrate the method of forcing the feed water through the apparatus.

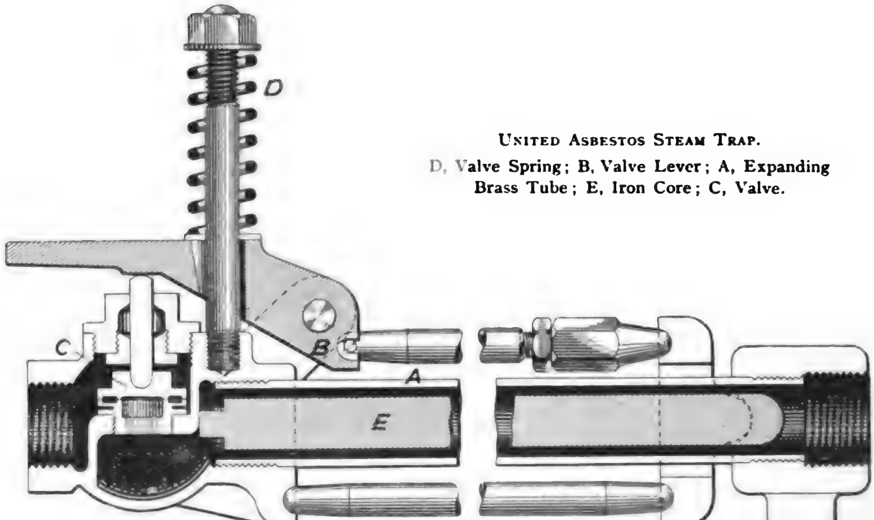
TYPICAL SECTION OF GREEN'S ECONOMISER.

Rod Valve Taps.—Troubles due to the scoring of the valve in circular-action taps are common where hard water is used. Sediment collects in the inlet passage and bearing on the circular wearing face of the plug eats into it and also cuts a groove, thereby causing leakage. A new type of rod valve tap was shown us by the UNITED ASBESTOS CO., LTD., which quite removes this objectionable feature in taps. From the sectional views it will be

ROD VALVE TAP, WITH SEDIMENT-BREAKING STEM.

seen that a circular rod passing between two glands forms the moving element, and at the upper end the sediment collects. When opening the valve the rod breaks through the sediment, which is blown down the central stem when the valve-holes rise through the gland and allow both steam and sediment to pass through. The wearing portion is the very limited area presented to the steam and sediment by the upper stem of the valve-rod. A lever engaging with a grooved collar on the rod serves to close and open the valve.

The exhibit of the company also included numerous asbestos specialities, among which we mention uacolite, or asbestos slate, a form of which is made up specially for electrical purposes. It can be enamelled like ordinary slate with any finish desired.



United Asbestos Steam Trap.
D, Valve Spring; B, Valve Lever; A, Expanding Brass Tube; E, Iron Core; C, Valve.

An Efficient Steam Trap. — There are many steam traps in use to-day, and the design varies almost in proportion to the number. At the exhibit of the United Asbestos Co., Ltd., we inspected a new form of expansion trap which has decidedly good features. It is of the expansion type, and, as will be seen by the attached section, is of simple construction, being without floats and moving glands. Within a brass tube is a solid rod which forms an annular space for water, and ensures rapid condensation and cooling. When steam is in the tube expansion occurs, and the side rods are slacked in their contact with the lever shown in the section. The spring can then exert its full pressure on the valve through the lever and valve pin. When contraction takes place the rods press on the lever and relieve the downward pressure on the valve, which is assisted to leave its seat by the hydraulic pressure below it. The extra area of the valve admits of its opening both promptly and widely, so that the trap discharges at full bore every time. The re-admission of steam into the trap causes the valve to at once sharply close.

Diesel Engines.—Among the novelties at Olympia was the Diesel patent crude oil engine which was shown direct coupled to a dynamo. It may seem strange to refer to an engine as a novelty when about 2,000 have been sold, aggregating nearly 100,000h.p. But it happens that this was the first occasion on which such a plant has been exhibited in this country, and in this sense it was a novelty, and a very interesting one. The fuel used is crude oil, such as Texas, Pennsylvanian, or Roumanian, and it is quite uninflammable under ordinary conditions; lighted matches can be thrown into it with impunity. The engine has no vaporiser, naked flames, or igniter of any sort, and combustion is so perfect that the exhaust is without smoke or smell. For private house lighting a small plant such as that exhibited should at once compel attention. The plant is self-starting and current is available in from one to two minutes at any time. The cost is remarkably low, being about $\frac{1}{10}$d. per b.h.p. hour, with oil at 40s. a ton (2d. per gallon). Ten 16c.p. or twenty 8c.p. lamps fully incandesced for $\frac{1}{10}$d. per hour or for ten hours for 1d. should encourage the use of such plants in isolated districts. The engines are made in sizes from 8 to 800b.h.p. and many of the larger sizes are in use for light and traction purposes in central stations all over the world.

Indicating and Recording Instruments.—An entirely new series of continuous current indicating instruments was shown in operation at the exhibit of Messrs. Elliott Bros. These instruments embody many new and valuable features. They are interchangeable, both electrically and mechanically. A zero device is fitted outside the case, thus permitting slight corrections to be made at once. The moving coils are so wound that the resistance of the connecting leads forms a much smaller proportion of the total instrument resistance than usual. This feature enables small variations in the length of the leads to be made without materially affecting the instrument readings.

A New Inking Device.—The *bête noire* of recording instruments is undoubtedly the inking pen. This in many cases is messy, and in addition to making a poor record on the paper soils the fingers when handling the instrument. Messrs. Elliott have produced a new inking device which should become first favourite among recording instruments. It consists of a long trough fixed on the front of the instrument,

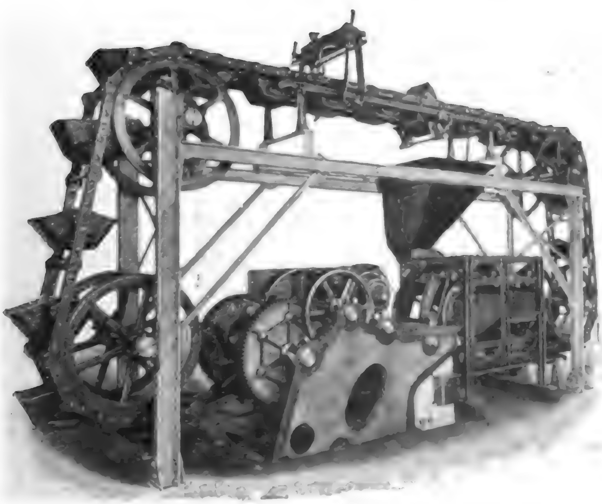
and containing about one hundred times as much ink as the ordinary prism-shaped pen. The pen itself is a simple form, comprising a piece of very fine bent tube through which the ink flows under capillary attraction.

Silent Gravity Conveyors.—A modern electricity works of any size is now always equipped with coal handling appliances. For transporting coal and ash, bucket conveyors are very widely used, and when properly designed are highly efficient. Messrs BABCOCK AND WILCOX, LTD., exhibited at their stand a doubled chain length of their silent gravity bucket conveyor. This was directly geared to an electromotor, which kept the conveyor constantly in motion. The conveyor comprises a train of tipping cars linked together, and so balanced as to be operated with a minimum of power. The driving device consists of a spur-geared engine operating two sets of pawls, which successively thrust the chain in the direction of its travel. Any wear in the chain links is compensated, so the cost of upkeep is practically nil. The extreme flexibility of the conveyor is exemplified by the ease with which its direction of travel can be changed either from the horizontal to the vertical in the same plane. The conveyor is practically automatic in its cycle of action, there being no handling of the material from the delivery to the receiving points. We understand from the makers that very marked economies are possible with this class of conveyor. For instance, in conveying and lifting four tons per hour to a height of 40ft., ten hours per day by a conveyor costing £1,000, allowing for interest on capital and expenditure, attendance, oil, motive power, depreciation, and

ROTARY PERMUTATOR.
(Bat Electrical Company.)

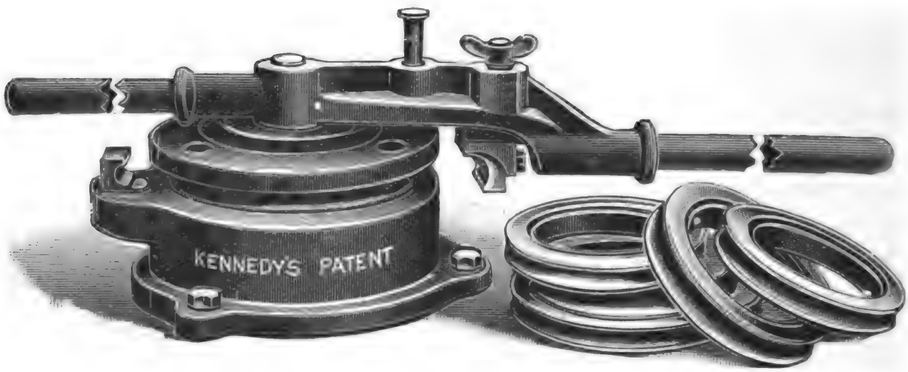
repairs, the cost does not exceed one halfpenny per ton. Station engineers will, we are sure, be interested in these figures.

Models were also exhibited of the well-known Babcock and Wilcox water-tube boiler and mechanical stoker to which engineers will need no introduction. Water softening and purifying plant (Guttmann's patent) was shown in model form This apparatus has proved itself highly efficient in practice.



SILENT GRAVITY CONVEYOR.
(Babcock and Wilcox, Ltd.)

Rotary Permutators.—Alternating current must frequently be converted into continuous current for accumulator charging, electrolytic work, &c. For this purpose a simple rotary converter is being exploited by the BAT ELECTRICAL COMPANY, who exhibited the first two machines ever shown in this country. Instead of heavy revolving masses of copper and iron, only a small portion of these is rotated, in addition to the brushes, which are generally fixed. An annular transformer comprises the stationary element, and the secondary winding is connected by numerous taps to a fixed commutator. The rotary element runs at a synchronous speed, and is excited from the direct current drawn from the commutator itself. Slip rings above the revolving brushes collect the continuous current. Over 5kw. the machines have an efficiency of 80 per cent., whether single or multiphase, the power factor being 90 per cent.

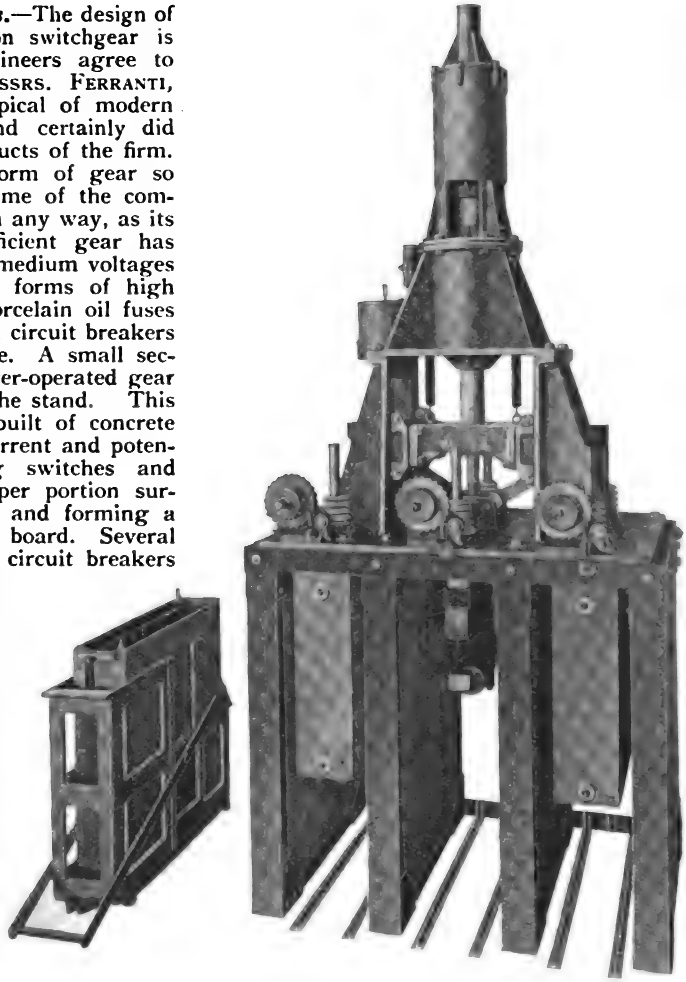


KENNEDY PATENT BENDING MACHINE.

Tube Bending Machines.—A decided novelty in the way of tools for wiring work was the Kennedy patent bending machine exhibited by Messrs. J. BARKER AND CO., LTD., the sole London agents. Iron and steel tubing can be bent cold with this machine to the narrowest conceivable radius, so that awkward elbows are obviated and the expense of cutting and screwing is reduced to a minimum. It will be noticed from the illustration that the device is exceedingly simple. One man can easily work it, and tubing up to 1in. in diameter can be readily bent even when cold. A great variety of bends and specially tortuous work formed a particular feature of the exhibit, and wiring contractors are, we understand, making extensive use of the machine. By its employment the greatest bugbear of electric lighting—the right-angled bend with its abnormally sharp turn in the wire—is entirely done away with. The extensive London premises of Messrs. John Barker and Co., Ltd., are wired with some 200,000ft. of screwed steel tubing, and by the employment of the bending machine not one single stock bend or elbow was introduced. The exceptionally wide range of work which can be undertaken with this machine is a full justification for its extensive use by electrical contractors. It seems to us to solve one of the knottiest problems of the steel conduit system of wiring.

THE EXHIBIT OF FERRANTI, LTD. METERS AND SWITCHGEAR OF ALL KINDS.

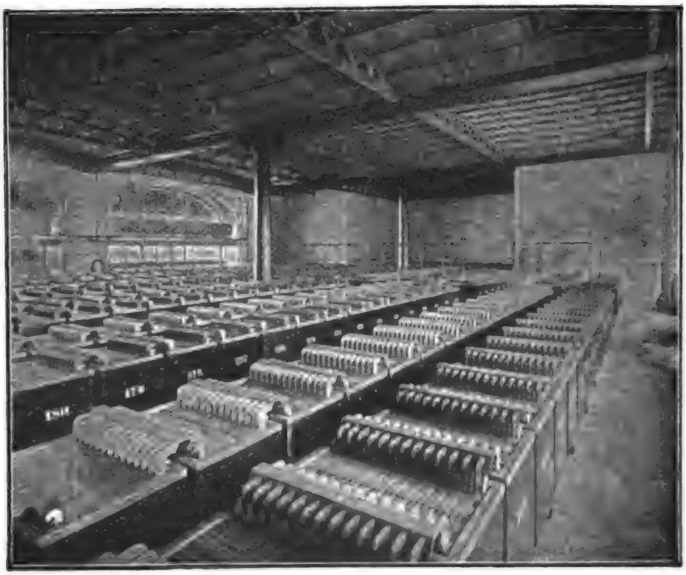
Switchgear Developments.—The design of central station and substation switchgear is a matter upon which engineers agree to differ. The exhibit of MESSRS. FERRANTI, LTD., was in every way typical of modern switchgear developments, and certainly did full credit to the recent products of the firm. The wall surface cellular form of gear so long associated with the name of the company did not need pushing in any way, as its reputation as the only efficient gear has already been established for medium voltages and outputs. In the latter forms of high voltage gear the familiar porcelain oil fuses are replaced by automatic oil circuit breakers of the well-known tank type. A small section of a distance-control lever-operated gear was built up at one end of the stand. This comprised a lower portion built of concrete cells containing bus bars, current and potential transformers, isolating switches and circuit breakers and an upper portion surmounting the concrete cells and forming a gallery for a bench control board. Several very interesting and unique circuit breakers both for direct and alternate current were also shown. A carbon circuit breaker operating on a new principle was among these. The carbon block which is fixed at the top of the movable arm is arranged to swivel so as to ensure very good contact with its partner. The latter is attached to a sliding sleeve pressed upwards by a strong spring. This spring serves the double purpose of providing a quick break and of contact between the carbon blocks for a time sufficiently long to allow the main contacts to clear. The break is closed by a simple toggle joint and no solenoid is used for the tripping mechanism.



FERRANTI, LTD. FIELD 5,000KW. REMOTE CONTROL SWITCH.

Remote Control Switches.— Electrically operated switches have got the name of being somewhat complicated. The application of electric power to large switches is not so simple a problem at it may appear at first sight. There are numerous types on the market, but we have seen nothing quite so simple as the Ferranti, Ltd.-Field form. A 5,000kw. switch was exhibited and shown in operation. A special tandem pull magnet is employed, and with a single plunger a pull equivalent to that of a magnet twice the length is obtained. The switch is held in by a toggle joint, which is broken by the tripping magnet when opening the switch. No brickwork is required, the entire switch being self-contained. A special form of controller is used which removes all possibility of uncertainty in closing the switch.

Tudor Accumulators.—The majority of the British-manufactured accumulators were exhibiting at the Exhibition, and made a fully representative show for this branch of the industry. The TUDOR ACCUMULATOR CO., LTD., showed a large number of their standard stationary cells in glass, lead-lined wood, and lead boxes, ranging in capacity from 60 to 7,500 ampere-hours. The internal arrangement of the cells could be easily inspected, as two of the largest types were shown with their sides removed. Specimens of plates both formed and unformed were shown, and the form of structure was evident. We understand that the new design of negative plates recently introduced by the company has circumvented all difficulties, and a much longer life can now be obtained from them. A special feature of the exhibit was an automatic regulating switch of the

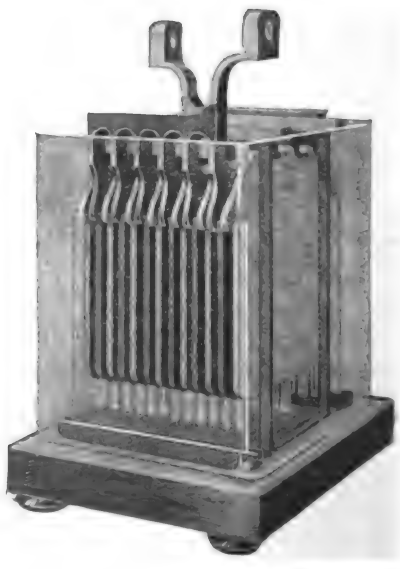


Typical E. P. S. Battery for heavy outputs.

either a strap handle or a miner's hook. The lamp is mounted at the front of this case, and fitted in a bull's-eye lantern protected with a stout guard. The lamps are of the Osmi type, with high efficiency filament, which ensures long light.

Hart Accumulators.—A complete battery of sixty Hart standard lighting type cells was erected on varnished pitch pine stands at the exhibit of the Hart Accumulator Co., Ltd., This battery has an output of 360 ampere-hours at 110 volts. The plates are suspended from glass slabs, thus allowing for free expansion in all directions. A flanged glass separator is used, and the supporting slabs are fitted with grooved blocks of teak, these, in conjunction with a teak frame, completely surrounding the plates and preventing any buckling or spreading. The ampere-hour efficiency of these cells is 92 per cent., and the watt-hour efficiency 78 per cent., on a full discharge. Numerous other cells and batteries were shown, these including a motor-car type and ignition batteries.

Pritchetts and Gold Accumulators.—Although the dimensions of their stand were not so large as some others, Messrs. Pritchetts and Gold's exhibit was fairly



Complete Hart Cell in Glass Box.

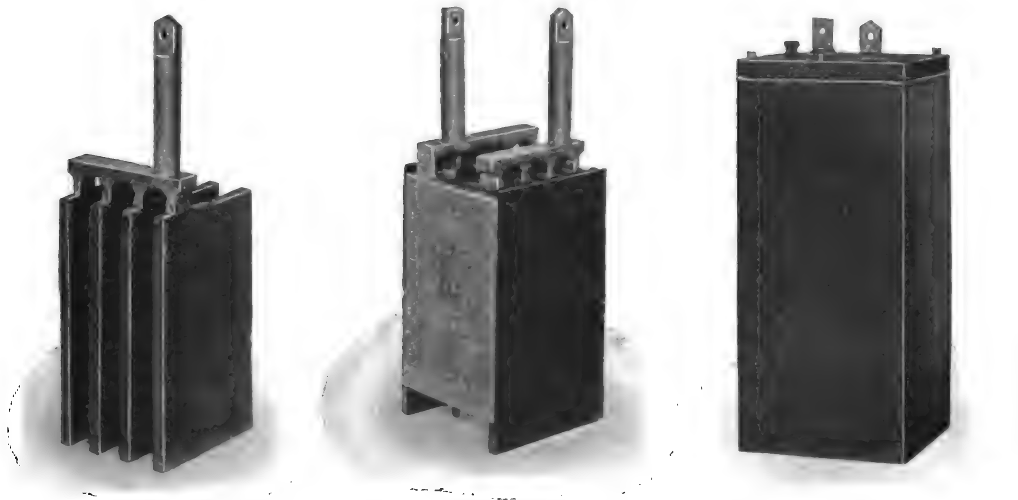
" Trumpy " pattern, for which the company are sole agents in this country. The switch is electrically operated, and can be used not only for keeping constant voltage, but also for working a regulating switch at a distance.

E. P. S. Batteries.—As the oldest and premier company devoted entirely to the manufacture of accumulators, the Electrical Power Storage Co., Ltd., naturally made a good show at Olympia. A very extensive display of their many types of accumulators was made, from the largest central station cells to tiny ignition accumulators. The company has done a very extensive business in supplying accumulators to central stations and private houses; and consequently has obtained unique experience in this branch of electrical work. Attention has also been paid to portable cells for traction and motoring work. Samples of these were shown at the Exhibition, and we understand it is possible to drive a carriage a distance of fifty miles with a set of accumulators weighing 8cwt., whereas with the older types it would have required at least 22cwt. to do the same work. E.P.S. moting type cells are used largely for electromobiles and launches. Each cell weighs 22lb., and has an output of 11 watt-hours per lb. of cell. It is capable of giving a discharge of 120 ampere-hours.

Electric Safety Lamps.—A number of miners' electric safety lamps and hand lamps were shown at the E.P.S. stand. These are exceedingly compact, and will burn upwards of 17 hours on one charge, 2½ candle-power light being emitted. The batteries are contained in polished wood outer cases, and have

representative of their high-class storage batteries. The "Pritchett" standard cells in glass boxes of various capacities for lighting and power purposes were shown, and cells of two sizes were erected on standard pitch-pine stands. All the cells exhibited were at once noticeable by their substantial construction and capability for hard work. The positive plates in these cells are formed by the Planté process, and are $\frac{1}{2}$in. thick. They are solid cast, consequently are very durable and capable of standing the hardest work and roughest treatment. The negative plates are of an improved pasted type $\frac{3}{8}$in. thick, and are very strong mechanically. The construction of the cells is such that all the plates are suspended from the edges of the glass boxes, and from the absence of ties of any kind inside the boxes the plates are free to expand in all directions. The efficiency of the "Pritchett" cells is very high, 95 per cent. ampere-hour efficiency and 80 per cent. watt-hour efficiency having been obtained in actual practice.

Train-Lighting Cells.—There was also exhibited a specimen of a cell specially designed by Messrs. Pritchetts and Gold for train lighting. This cell has many special features, based on the results of years of experience in the exceptional strains train-lighting batteries are subjected to. Although the lighting of trains by electricity has not become universal, there are signs that it will be much more largely adopted in the future. The conditions of service for cells for train lighting are exceptionally severe, and no cell but the strongest and best can be employed satisfactorily for any length of time. The "Pritchett" train-lighting cells are constructed as nearly as possible on the same principles as their ordinary cells. The plates are exactly the same, only of a different size. The method of fastening down the lid is exceedingly neat and ingenious, and a strong rubber ring fitted into the rebate of the lid makes a perfectly acid-tight joint. It has been the practice in the past to use cells not specially designed for use in train lighting, with the inevitable results. The "Pritchett" train-lighting cells, however, have been designed in all respects to meet the exacting conditions imposed. The "Pritchett" train-lighting cells have been in use some time on the Midland Railway, Lancashire and Yorkshire Railway, Great Western Railway, Caledonian Railway, Great Central Railway, Indian State Railways, &c., and have given in all cases most satisfactory results.



PRITCHETTS AND GOLD TRAIN-LIGHTING CELL, SHOWING POSITIVE AND NEGATIVE ASSEMBLED ELEMENTS AND COMPLETE BATTERY IN CONTAINING CASE.

Yacht-Lighting Batteries.— A standard yacht-lighting cell in teak lead-lined box was also shown, having a capacity of 770 ampere-hours. This cell is also designed to meet the special requirements of yacht lighting. The plates are arranged so that there is ample space beneath the plates, rendering frequent washing out unnecessary, and there is also a large space between the tops of the plates and the lid. Owing to yacht-lighting cells having of necessity to be placed in rather inaccessible positions, it is essential that they should be of such construction and design as not to require frequent inspection, washing out, or topping up, and owing to the varying temperatures to which they are subjected, and the excessive vibration when the yacht is in a heavy sea, it is necessary that yacht-lighting cells should be very strong mechanically. An inspection of the special "Pritchett" yacht-lighting cell will show how very thoroughly these points have received attention.

The New Climax Plate.
(Pritchetts and Gold.)
Exhibited in public for the first time at Olympia.

Climax Plates.—Another feature of Pritchetts and Gold's exhibit was the Climax plate. These plates are first cast in solid slabs and then put through a patent machine, which produces an enormous number of very fine vertical laminæ on the surface of the plate. These laminæ are, as it were, pressed out of the solid slab, thus compressing the lead, which renders the plate extremely durable. A thick solid core runs through the plate, giving it great mechanical strength and high conductivity. The results obtained from this plate at high discharge rates are remarkable, the capacity of a Climax plate at one, two, or three-hour discharge rates being from 30 per cent. to 40 per cent. more than that obtained from any other plate on the market of equal superficial area.

Lithanode Ignition Accumulator.

(Longstreth's, Ltd.)

The tubes conducting the gases to the valve pocket will be noticed, also the vent from the chamber to the atmosphere. Spilling of the electrolyte is impossible.

Lithanode Cells.—The exhibit of Longstreth's, Ltd., typified a distinct departure from the common forms of secondary batteries. In the Lithanode cell no special support for the peroxide of lead is necessary as a solid cake of that material, when surrounded by a frame of lead, is found to be sufficiently firm for the purpose. Plates of any size are built up ranging from the smallest test cell to central station batteries. For ignition purposes an unspillable cell has been made by the company for a considerable time and has proved quite successful. It is possible to submit these cells to very rough usage without there being any signs of spilling or leakage.

Prepayment Meters.—In all prepayment meters hitherto introduced complicated switching mechanism has been necessary to the ordinary meter mechanism, involving chances of failure, increased first cost and upkeep. In the Mordey-Fricker electrolytic prepayment meter there are no mechanical movements, and the cut-off after the prepaid current has been consumed is infallible. The simplicity of the meter permits of a cheap instrument with practically no charge for up-keep.

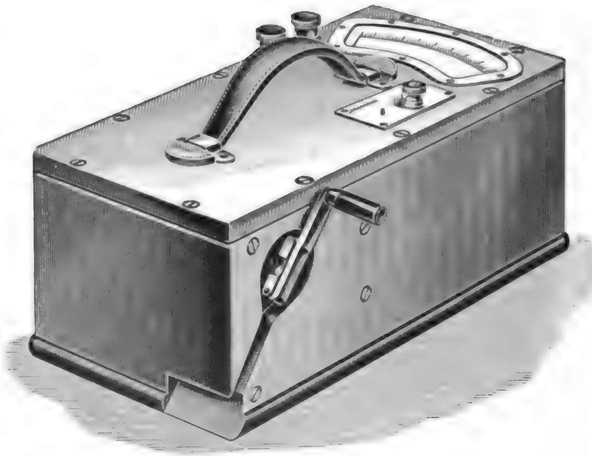
The meter comprises a depositing cell wherein the cathode is fixed and partitioned off from the anode by a perforated celluloid diaphragm. The anode is a roll of thin copper strip carried on the upper part of the plate covering the cell. A definite length of this strip, which is rolled to a uniform thickness, is fed into the electrolyte over a sprocket roller through a slot in the cover plate by the operation of each coin. When the portion thus immersed has all been dissolved by electrolysis and a like quantity deposited on the cathode, the circuit is automatically broken at the surface of the electrolyte.

In the penny meters a maximum feed corresponding to eight coins may be immersed. The average drop depends on the length of anode immersed, and with one coin's worth only does not exceed 1.3 volts per ampere passed. The deposited copper is purchased by the makers at market prices.

Automatic Truck Weigher.—Messrs. W. and T. Avery, Ltd., exhibited a novelty in the shape of an automatic self-registering truck weigher. The net weights are indicated and totalled automatically as well as the number of loads passing over the machine counted; skilled labour is entirely unnecessary. A complete and reliable record can be automatically obtained of a day's weighings, or of weighings for any given period. The machine has three counters; one indicates the net weight of each weighing, the second records the total of all net weights passed,

and the third counts how many loads have been weighed.

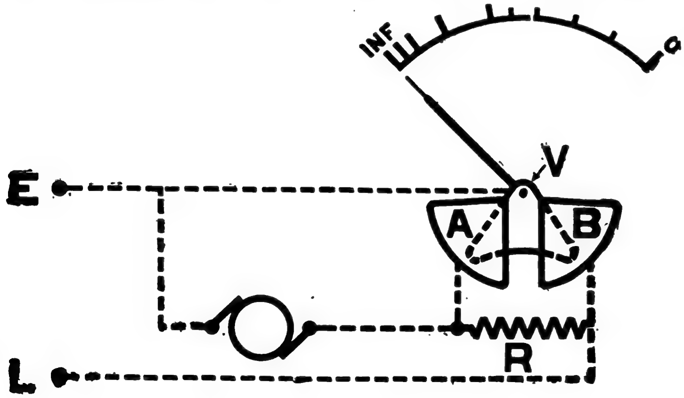
Testing Instruments.—Like other electrical apparatus, instruments have lately received their full share of attention, and have been improved accordingly. Where in past times two instruments were employed, their functions are now combined within the compact limits of a single case. The N.C.S. ohm-meter and generator exhibited by NALDER BROS. AND THOMPSON, LTD., is an example of economies of this character. The instrument consists of a generator and ohm-meter of the electrostatic type combined in one polished wood case. The generator is an improved form, being fitted with carbon brushes and a special commutator. They are built for not less than 500 volts, but this pressure can be increased to 1,200 volts by using a different generator. The ohm-meter consists of a vertical needle with thirteen parallel vanes about .3in. apart. These work in sets of specially constructed inductors. The instrument is, of course, quite unaffected by external fields, and is also lighter than the coil type. The instrument works as follows:—The generator has one of its terminals attached directly to one quadrant (A) of the electrostatic ohm-meter and the same terminal attached through a resistance R (which is wound on porcelain insulators, and contained in the case of the instrument), to the other quadrant (B) of the ohm-meter. The other terminal of the generator is connected to the vane, V. In actual practice, however, four sets of inductors are used, the opposite pairs being connected together. The quadrant, B, is attached to the line to be tested, and the vane, V, is attached to earth. When the insulation resistance between the earth and line is infinite, there is no current flowing through the resistance, R, and the vane, V, takes up the position shown in the diagram.



COMBINED TESTING SET OHM-METER AND GENERATOR FOR PRESSURES UP TO 1,000 VOLTS. (Nalder Bros. and Thompson, Ltd.)

When a current flows from E to L there is a drop of potential due to the current flowing through R; the quadrants A and B are then at different potentials, and the vane, V, takes up a new position, which is determined by the difference of potential and the shape of the vane. The vane, V, is shaped approximately as shown, so as to be in stable equilibrium at all parts of the scale. The instrument is made for two standard pressures, 500 and 1,000 volts, giving three standard ranges of resistance, namely, up to 20 megohms, up to 50 megohms, and up to 100 megohms at each voltage. In each case the instrument is provided with a switch to reduce the top reads to one-tenth of this value. The weight of the instrument complete in case is 13¾lb.

Frahm's Speed Indicator.—An ingenious speed-indicating device comparatively new to this country is the Frahm, which was exhibited by W. LUCY AND CO., LTD., among their other specialities. The principle of resonance is employed in the instrument, and a number of attuned tongues of best watch-spring steel, are screwed to a bridge fixed to an elastic support in the small sizes, and placed in the larger types on a firm base. When subjected to vibration that spring in sympathy will at once be set in motion, vibrating over an area wide enough to give the moving lip of the spring the appearance of a single line. When placed before a graduated scale the spring vibrating records the value of the vibrations in frequency, or revolutions per minute, as the case may be. With turbines the instrument need only be placed on the machine itself to obtain a



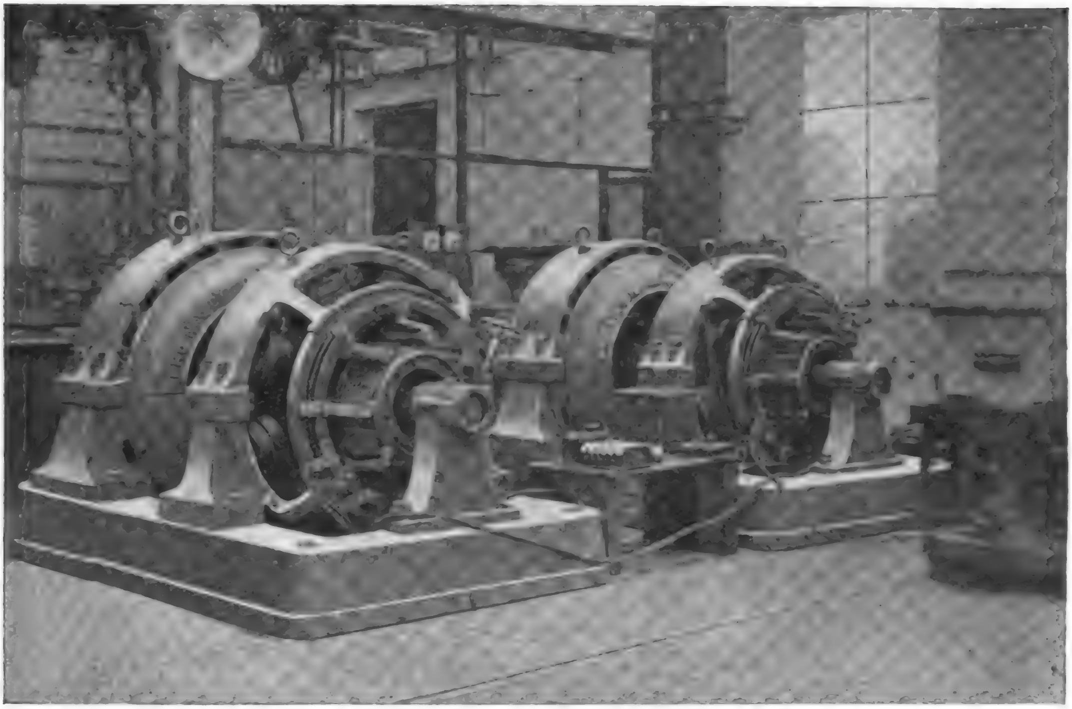
record of its speed. The speed of dynamo electric machinery is obtained, in the case of alternating currents, by connection through a resistance in the network, and with continuous currents by the use of a small alternator. The absence of moving parts makes the instrument sound and serviceable, while the very wide range possible should make it especially useful for electrical purposes.

Phœnix-Pohl Dynamos.—The exhibit of the PHŒNIX DYNAMO MANUFACTURING CO., LTD., of dynamos with commutating poles, attracted considerable attention. Machines of this class have only recently been built on a large scale in this country, and the P.D.M. Company first carried out extensive tests with dynamos and motors built on these lines. The embodiment of these in the latest types of their dynamos and motors has resulted in machines which allow of increased outputs and overloads respectively, without destructive sparking or loss of efficiency. As is well known, with ordinary shunt machines the armature current produces a cross field which distorts the main field, and alters the position at which, for a given load, good commutation takes place. A varying load therefore demands that the brushes be moved if sparking is to be avoided. By the use of an auxiliary pole with winding in series with the armature, the field ensuring current reverse in the armature coils can be strengthened, and the distorting effect of the increasing armature load neutralised. With the Phœnix-Pohl coils this principle has been employed with highly satisfactory results. The poles are very short, and have faces which decrease in breadth in the direction of rotation to furnish the requisite equalising of the field. Trials conducted at the Phœnix Works proved that machines fitted with the poles, whether as dynamos or motors, could be subjected to very severe handling, and in no instance could destructive sparking be produced at the commutator.

Dynamo and Motor Ventilation. — The provision of means for removing heated air from the vicinity of core and coils of dynamo electric machines is a matter of considerable importance. The Phœnix Dynamo Manufacturing Company have paid special attention to this subject, and both armature and field of their machines are provided with ventilating ducts. The revolving element is made to draw in air at the shaft and expel it through the armature core and coils, and this blast passes also through the openings provided in the field coils, which are thereby kept constantly cool. The temperature rise can by this method be kept within the limits of 35-80° F.

Duplex Pumps.— The most prominent exhibit of the BRITISH ELECTRIC PLANT COMPANY was a duplex double-acting variable stroke boiler feed pump (Spence's patent), driven by a constant speed motor. The capacity is 3,000 gallons per hour against a boiler pressure of 200lb. per square inch. The stroke is variable by means of an extremely simple worm and wheel gear with star wheel and tappet, from 0in. to 5in., step by step at each

EXHIBIT OF THE PHŒNIX DYNAMO MANUFACTURING CO., LTD.

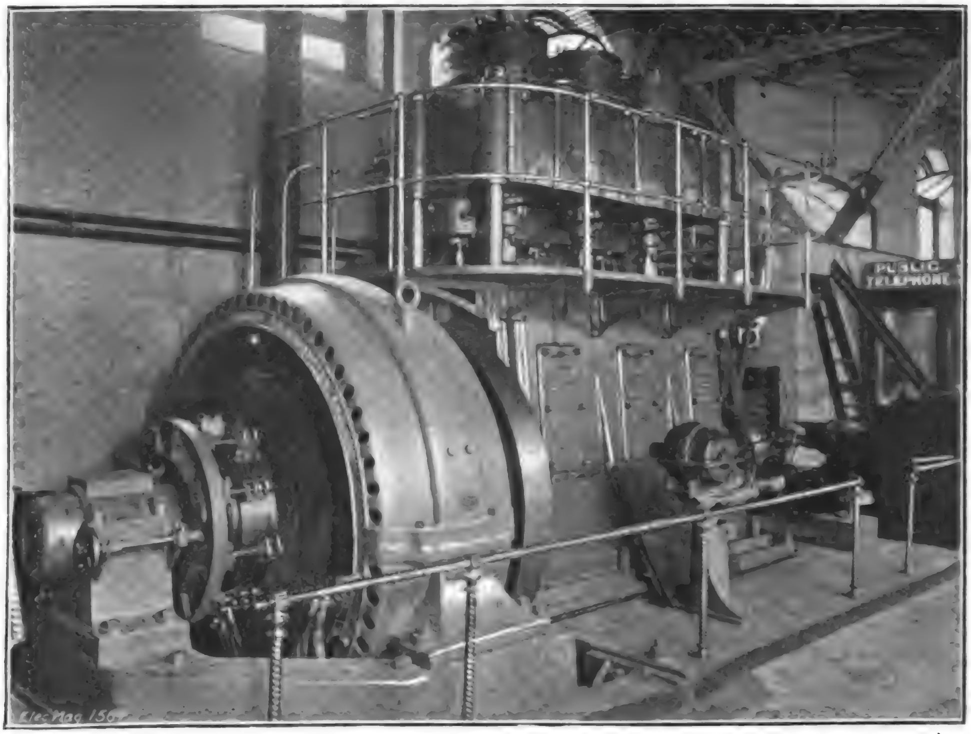


Two Motor Generator Sets, with Phœnix-Pohl Special Commutating Poles, on Test Plate, at Works, previous to shipment.

revolution of the crank shaft, and, of course, the delivery is correspondingly varied. A special feature of the design is the care taken to absolutely prevent the slightest trace of air lock, and this feature, together with adequate air vessels on both suction and delivery sides, has made it possible to obtain a delivery substantially as uniform as that from a three-throw pump. The pump was driven through single reduction gear—raw hide pinion and machine-cut cast-iron internal wheel—by a B.E.P. four-pole shunt motor, developing 12b.h.p. at 585 revolutions per minute on 440 volts.

Cables for Lighting and Power.—A large variety of junction boxes, feeder pillars, &c., as required for lighting and tramways systems, and also for colliery work, was exhibited by Callender's Cable and Construction Co., Ltd. Cables of various types and sizes, as supplied to numerous corporations, &c., were on show, together with a comprehensive collection of standard feeder pillars, network boxes, service boxes, and fuse boxes. The feeder pillars on view had their fittings mounted on the "double porcelain insulation" principle, which gives very superior results to those obtained from the use of slate or marble bases, and which has been adopted and patented by this company. The company exhibited a coal-pit road and a model of a shaft, together with a selection of special mining boxes and various types of cleats and cable suspenders, for taking cables down shafts and along the workings.

Reversible Boosters.— The comparative paucity of exhibits of heavy dynamo electric machines did not prevent the Lancashire Dynamo and Motor Co., Ltd., from showing a number of representative types of motors and dynamos manufactured by them at Trafford Park, Manchester. Prominent among these was an automatic reversible booster, which is now being largely taken up for tramway purposes. The motor for this is wound to run off 500-550 volt circuit, and the booster is capable of developing 200amps. 0-120 volts continuously, 300amps. for one hour, and 400amps. for five minutes, at 0-60 volts, the set running at 800 revolutions per minute. Its advantages may be summarised as follows: The laminated fields of the booster give very quick reversal, and the booster is easily paralleled. Further, it is possible to arrange by suitable adjustment of the field resistances, either for constant load on the generator or for load on the generator varying within certain limits, anything above these limits being taken by the battery. The alteration of the



500h.p. High Speed Unit which furnished Continuous Current to the Exhibits at Olympia.

Though essentially erected for actual service, the set was in the hall proper and formed an attractive exhibit, being frequently subjected to close inspection. Steam was supplied from a Babcock and Wilcox boiler, and the main switchboard was by Reyrolle and Co., Ltd.

dynamo shunt regulator does not necessitate any alteration in the booster field regulators, as it is self-regulating. There is absolutely no shunting, and charge and discharge currents can be adjusted to suit the particular conditions of the generating station. The same firm also exhibited induction motors of 10-14 and 20h.p. standard continuous current motors and balance sets.

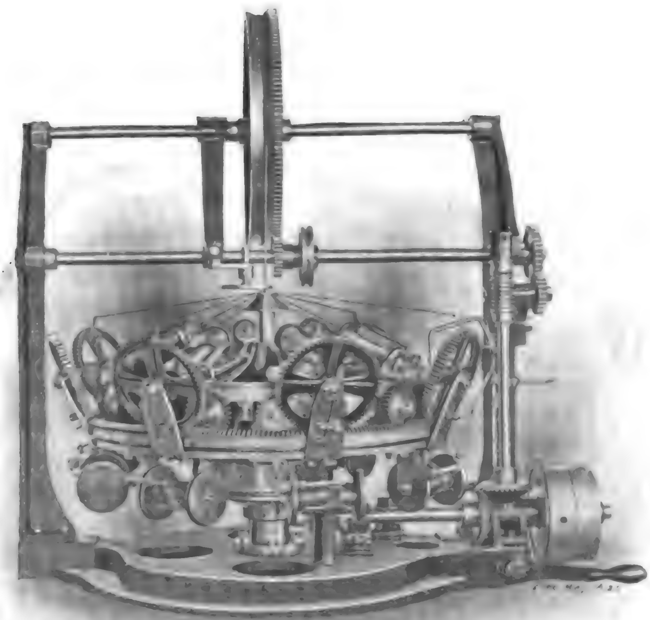
Continuous Current Power Plant.—The continuous current required for the Exhibition was furnished from a special set installed for the purpose. The engine was one of Messrs. Davey Paxman's well-known Paxman "Peache" type, three-crank compound, capable of developing 440-500h.p. as normal load, running at 325 revolutions per minute. The high pressure cylinders are 11in. diameter, low pressure cylinders 22in. diameter, by 12in. stroke. The generator was of Messrs. Parker's make, ten pole compound wound, coupled direct to the engine, and having an output of 1,150 amperes at 250 volts. Both engine and generator came direct to Olympia from the works of the respective makers, and were assembled on the site for the first time, running on load the first night and subsequently without a hitch. This performance testifies to the excellent design and workmanship of both engine and generator, and is something of which both manufacturers may well be proud.

Allen Engines.—Messrs. W. H. Allen, Sons, and Co., Ltd., have made a reputation for their high-speed steam engines in the field of electric lighting and power, and it is only natural they should be found exhibiting at Olympia. On their extensive stand they were showing a three-crank three-cylinder compound enclosed silent running engine fitted throughout with a system of forced lubrication. This engine had an output of 440b.h.p. at 400 revolutions per minute. and was suitable for a steam pressure of from 100lb. to 200lb. on the square inch, condensing or non-condensing. On the same stand was a two-crank compound enclosed silent running engine fitted with a system of forced lubrication, having cylinders 8in. and 15in. diameter by 7in. stroke, capable of developing 130b.h.p. at a speed of 500 revolutions per minute with a steam pressure of 100lb. to 200lb. on the square inch, condensing or non-condensing. This engine is suitable for coupling to a dynamo for electric lighting or transmission of power

work. The exhibit also included one single-crank single-cylinder high-pressure enclosed engine, a surface condenser, a steam-driven twin air pump of the Allen-Edwards design, a three-throw Allen-Edwards air pump, and a crank-shaft taken from one of the company's three-crank compound 600h.p. engines.

High Speed Braiders.—One of the cleverest devices we inspected at the Exhibition was an ingenious machine for braiding cables, packings, cords, &c. For cable makers it should prove a valuable time-saver, and, moreover, its principle and construction obviate the objectionable breakages so common to other bobbin machines. A glance at the adjoining illustration will make the arrangement at once clear. An annular frame carries a number of bobbins placed radially and at a considerable angle, so that the threads, as they leave the coils, pass to the centre pivot of the frame and meet at that point. Concentric with this circular frame is another annular track, provided with a rack and placed at a lower level. This is a path for a series of gear wheels carrying a guide, through which passes a thread from a bobbin hung below the carriage. This thread also leads to the centre of the machine, or braiding point, and, following the motion of the wheel, rises and falls in its path round the pivot. Eight such wheels make up the outer or braiding section of the machine. The carriages are set running in opposite directions, and the threads, by reason of the trochoid path followed by the threads from the outer set of bobbins, unite at the centre in a correct layer, which encloses the object or coil to be braided. Entire absence of strain on the threads admits of high speeds and more perfect work than can be obtained by other known processes.

Gratze Revolution Indicator and Recorder.—In placing this instrument on the market the manufacturers have studied a long-felt want for an accurate and reliable revolution indicator, not only for practical requirements, but also for cost. The action is based upon a new and novel principle, and the construction is such that the rotary portion of the instrument is entirely free and disconnected from the indicating or deflecting movement. These instruments are of British workmanship and material throughout, and as they are made in quantities of 100 to 200 per time each separate and individual part is interchangeable. The method of calibrating ensures absolute accuracy in the reading of the instrument, and the indicating needle is



HIGH SPEED BRAIDING MACHINE, WHICH WAS ONE OF THE NOVELTIES OF THE EXHIBITION.
It will braid up to 4yds. per minute, and is simplicity itself in its design and construction.
(High Speed Braiding Co., Ltd.)

GRATZE SPEED INDICATOR, FRONT VIEW.

quite *dead-beat* under all conditions of working. The instruments, moreover, may be reversed, or run at a much higher speed than the maximum indicated on the dial, without suffering the slightest injury.

Method of Driving.—This is variable, the chief method being, as usual, by a pulley

SIDE VIEW OF SPEED INDICATOR, SHOWING SWIVEL AND PULLEY.

and belting. This pulley is V-grooved, and is 4in. diameter, therefore it is adaptable as a surface cut meter. By placing a rubber ring round the groove of the pulley and holding the periphery against any revolving material, the indicating hand immediately gives a reading in feet per minute. The indicator may also be driven by a flexible steel shaft and adapter, which direct couples it to the machine of which it has to indicate the speed. Again, a flexible shaft, which may be direct coupled to the instrument, can be supplied with a spear-pointed piece of steel at one end, which may be pressed centrally into the end of any rotary shaft, thus enabling the user to take temporary readings.

GRATZE IGNITION ACCUMULATOR.

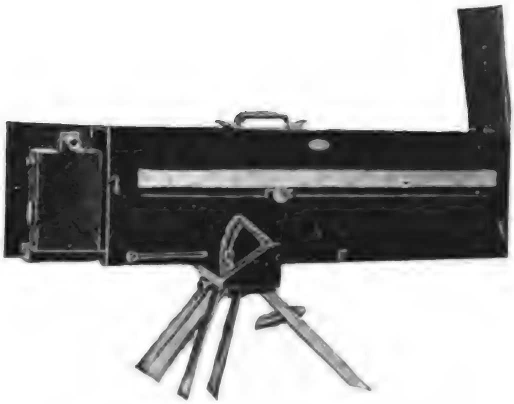
A total revolution recorder can also be supplied reading up to 100,000 or 1,000,000 revolutions, after which the recorder returns to zero and begins totalling up again, *ad lib.*

The instrument is light and portable, has a face of 5in. diameter, and is mounted on an iron pedestal in such a manner that it is possible to turn the face of the indicator in any direction without removing the stand.

Gratze Planté Accumulator.—The chief feature of this accumulator lies in the positive plate, and it is claimed that the difficulties hitherto attending the formation of cells by the Planté method are overcome. Moreover, the method now used by the GRATZE PATENTS AND ENGINEERING SYNDICATE, LTD., not only decreases the expense of the cells, but adds very considerably to the capacity of the plates, and also makes them very firm and hard, so that the tendency to buckle under heavy discharges is almost entirely obviated.

These cells will stand short circuiting for any length of time without injury to the plates, also the potential at a fair discharge current maintains constant at 2.2 volts. The manufacturers are shortly putting on the market an improved and fully patented cell for traction purposes, in which the above positive plate will be used; but the frames of the negatives are made of a very light *insulating* material. In experimenting with this type of cell, an output of 18 watt-hours per lb. weight was attained. Further particulars of this cell will be published in a future issue.

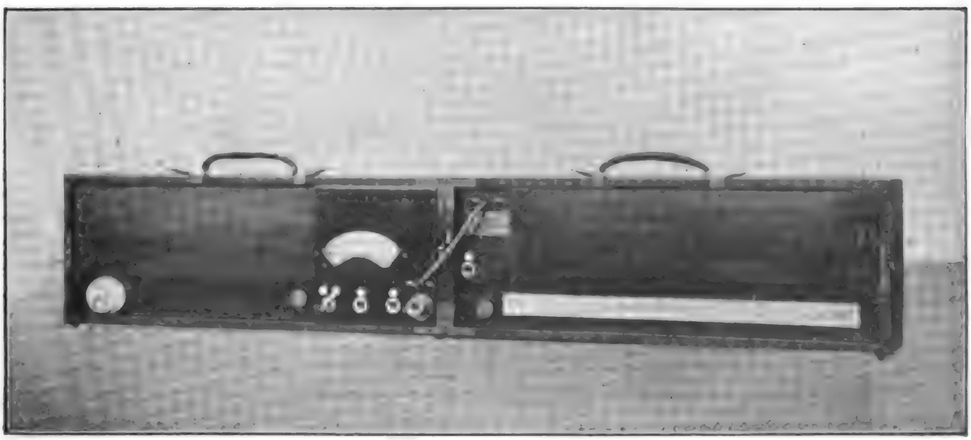
Inkless Recorders.—The design of electrical recorders has undergone vast changes since their introduction. The old clumsy sloppy patterns resembling stationers' shops are now giving place to neat instruments with never so much as pen or ink about them. At the exhibit of EVERETT, EDGCUMBE AND CO., LTD., was shown a new type of recorder, in which a new principle is embodied. The pen is replaced by a hardened steel point, which is tapped by an electro-magnetic driver, and caused to strike an endless ribbon against the paper. Every five seconds an electric clock sends impulses through the instrument circuit, and in addition to the record being made, the paper is notched forward and the ribbon moved. The position of the steel point is regulated by the usual instrument mechanism for voltmeters or ammeters, and it is claimed that a more accurate reading is taken than with pens, which are apt to be sluggish. The clock is a self-winding electrical mechanism of the Synchronome Company, and is external to the instrument. It may be used for any number of recorders, as well as clock dials about the station. For actuating the clock, energy is derived either from the supply mains or a battery circuit. These inkless recorders open up other possible applications of synchronised



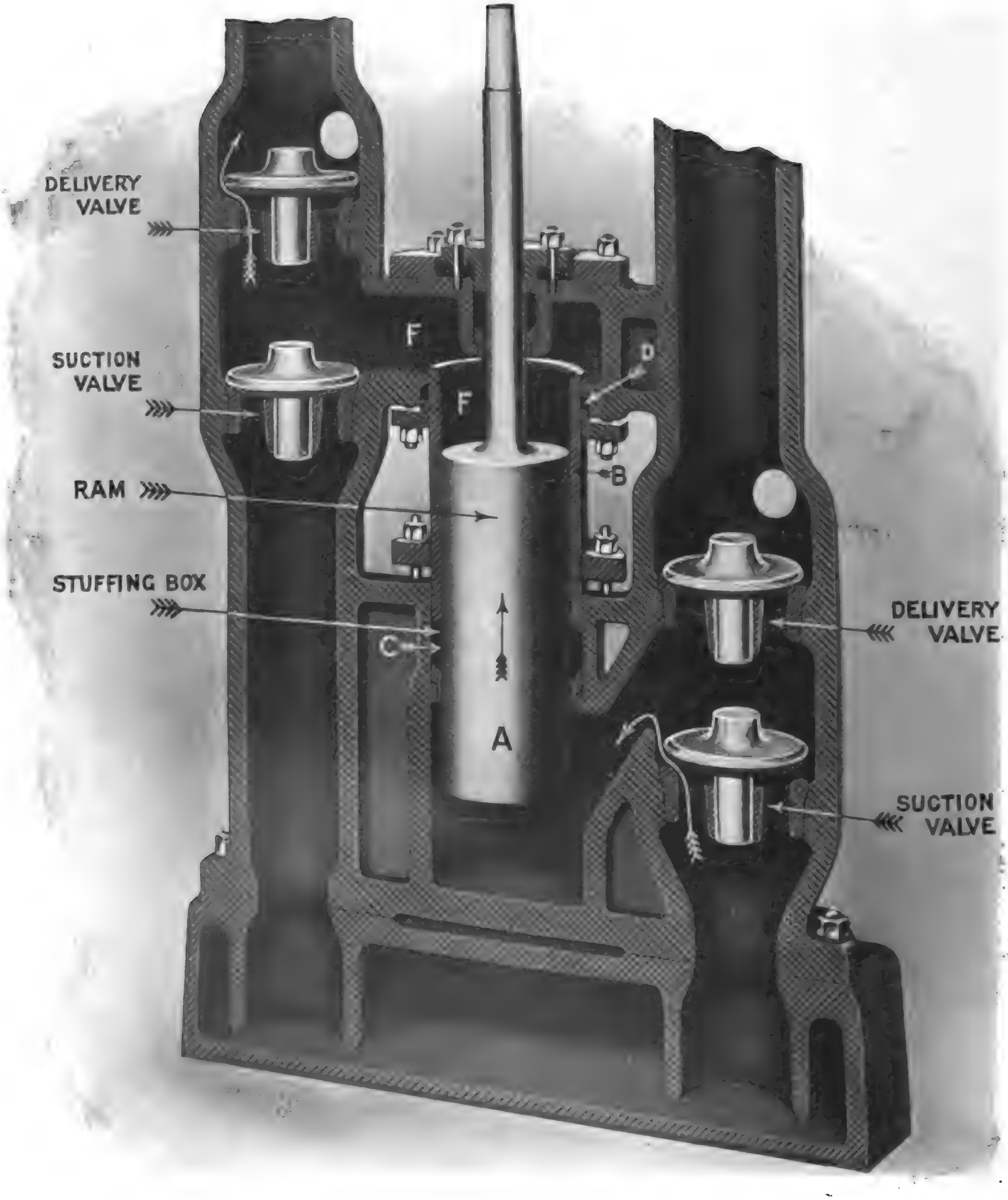
PORTABLE STREET PHOTOMETER (Everett, Edgcumbe.)

mechanisms for electrical purposes, and they certainly have all the appearances of reliability and efficiency.

Portable Watt-Photometers. — We also inspected at Messrs. Everett, Edgcumbe's exhibit a most useful device for central station engineers—a portable watt photometer. This instrument can be taken directly to a consumer's installation, and he can be convinced of the necessity or otherwise of changing his incandescent lamps. The illustration shows that the instrument is very compact, and moreover it can be used in broad daylight. A two range-wattmeter is connected up with the standard lamp and that to be measured, and a slider is arranged to alter the resistance of the pressure coil, when the lamp carriage is moved to obtain a balance. When the correct position is found a key is depressed and the instrument reads directly in watts per candle power of the lamp under test. No calculation is needed, and the



PORTABLE WATT-PHOTOMETER FOR MEASURING DIRECT THE EFFICIENCY OF CONSUMERS' INCANDESCENT LAMPS. (Everett, Edgcumbe.)



Sectional Elevation illustrating Principle of Pearn's New Double-Ram Steam Pump.
An illustration of the complete pump is shown on page 76.

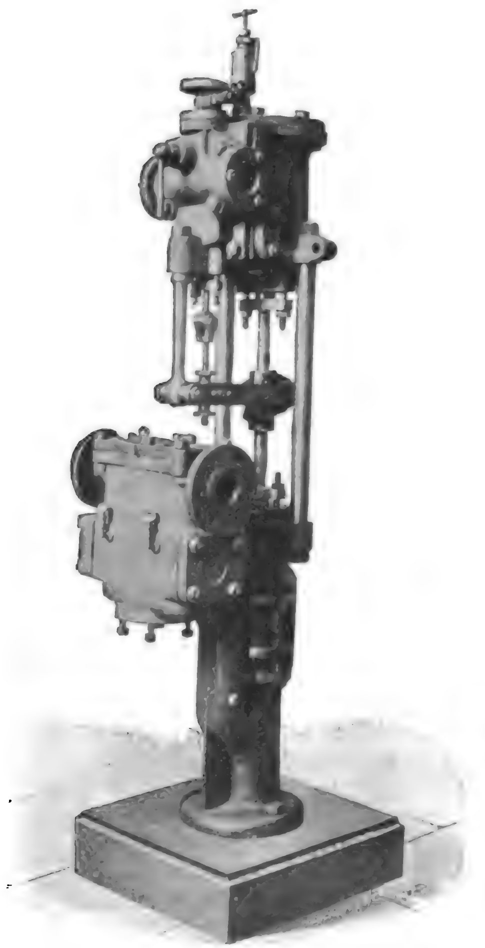
A. Ram.
B. Plunger Guide.
C. Lower Stuffing Box.
D. Upper Stuffing Box.

most untechnical consumer can see for himself what his lamps are actually requiring. Lamps should be changed when the consumption has increased by 20 per cent. due to falling efficiency, but it is difficult to persuade people of the necessity for the change.

New Things in Pumps.—The exhibit of FRANK PEARN AND CO., LTD., was in every way typical of improvements in steam and electrically-driven pumps. It contained one of the few novelties put forward at the show. A large number of different types of pumps were exhibited, but the chief feature was a double-acting pump for boiler feed purposes operating with one ram. The ram is steam driven from a single cylinder fitted with a special balanced valve which ensures easy admission of steam at the commencement of the stroke in practically the same manner as an eccentrically-moved slide valve. This valve, combined with the chief features of the pump, admits of great regularity in working. In practice the pump runs very sweetly without sign of shock or jar, and it can be actuated quite slowly. The method of packing the pump is shown in the adjoining illustration, and it will be seen that the ram can be packed in the same simple manner as a single acting pump. The illustration will also explain the principle upon which the pump operates. Among the other exhibits we noticed a particularly neat single ram pump driven by ½b.h.p. motor (Electromotors, Ltd.). The pump was single geared and is largely used for the supply of water to small estates, farms, &c. A type of electrically-driven sinking pump was also shown, the motor in this case being placed above the pump, which can be easily slung on account of the even weight distribution. Complete access can be had to the glands, valve doors, and bearings, and the pump is substantially built for long and hard service.

THE EXHIBIT OF FRANK PEARN AND CO., LTD. PUMPING PLANT OF EVERY KIND AND FOR ALL PURPOSES.

Electric Clocks.—The thoroughness of the committee's arrangements were exemplified in many details, and not the least important of these was the provision of clocks. Finding that Olympia was unprovided with a single timepiece, they arranged with the SYNCHRONOME COMPANY to equip the whole building with their system of uniform time service. Some twenty clock dials were erected in prominent positions in the hall, the annexe, the refreshment rooms and bars, including two handsome skeleton iron dials of 5ft. diameter suspended from the roof at each end of the great hall. These dials, being fitted with plate-glass centres, were transparent, and the "one-wheel" step-by-step movement was



PEARN'S MANCHESTER DOUBLE-ACTING STEAM PUMP.
The principle on which this pump operates is shown on page 74.

concealed by the bosses of the hands. They fittingly illustrated the modern method of electrical time service, which dispenses with ordinary clockworks and their inability to show accurate time, or even to keep together.

They were all operated from one self-wound controlling pendulum placed in the entrance hall. This instrument may be described as the combination of the essentials of a clock and a switch. That is to say, a switching action is required to be performed every half-minute to advance all the dials that amount of time, and this operation takes place automatically, each interval of thirty seconds being measured accurately by a seconds pendulum kept swinging by an impulse derived from one arm of the switch as it falls. The pendulum was daily compared with the Greenwich time signal, and by this means great accuracy of time-keeping was obtained throughout the whole building. The company also exhibited their clocks at Messrs. Verity's stall, the instruments shown being còmbined with two workmen's time recorders.

Time Recorders.—Messrs. HOWARD BROS., the patentees and manufacturers of the well-known "Dey" time registers, made a good display of these machines. The "Dey" is a very ingenious machine for recording the time of the arrival and departure of employees by means of a weekly combined time and wages sheet, which gives the numbers of the employees in numerical order with the whole of their ingoings and outgoings for the week on the line opposite their numbers, with extension columns for writing in the total number of hours worked, rate, and amount to pay. It can be arranged to suit any requirements, and for any number of hands up to two hundred on one sheet, and it is turned out in a manner creditable to the British firm who make it, and who guarantee its perfect working in every respect. The machines are made in four sizes, *viz.*, for 50, 100, 150, and 200 hands; where more work-people are employed than can be taken on the largest machine, further machines are required. These are numbered to correspond with the

VIEW OF COMPLETE DEY TIME REGISTER.
(Howard Bros.)

number of the workpeople or, as is recommended, placed departmentally according to circumstances, and as may be most advantageous to the employer. The machines described above may be called the ordinary "Dey," and for cost keeping, by means of an additional attachment, the time spent by employees on different jobs can be recorded on cards. This attachment does not in any way interfere with the ordinary time-keeping by weekly or daily sheets, but combines the two systems of time-keeping and cost-keeping, and is found extremely valuable where the actual times of arrival and departure of workpeople must be recorded, and also details of time spent on any particular piece of work.

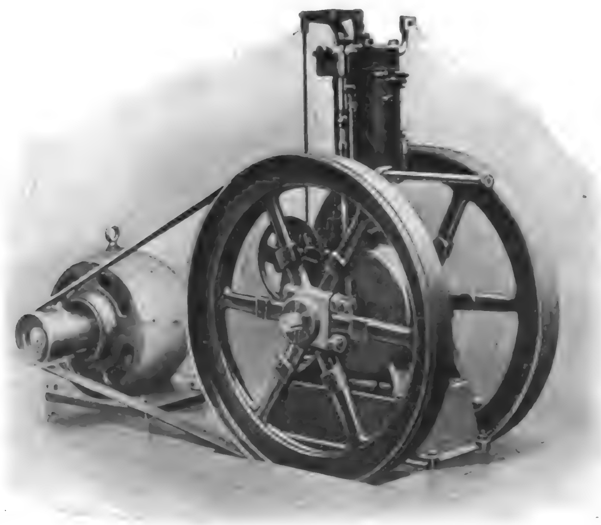
At this stand was also shown the automatic "Dey," which supplies the whole week's time on one sheet as above, but moves automatically from one period to another at the proper times, which renders it unnecessary for the machine to receive any attention whatever except once a week to wind the clock and change the sheet.

The latest improvement provides means whereby an employee arriving at his work after the specified time, or it may be a departure out of the ordinary time, makes his registration in such a manner as to be conspicuous when the combined time and wages sheet or cost card is examined. Employment has been made of an ink ribbon having two or more ink surfaces of different colours; for instance, one half the ribbon may be black and the other red, the black being ordinary time, the red to indicate late or unusual time.

350kw. Motor Generator.—The LAHMEYER ELECTRICAL CO., LTD., exhibited the only examples of heavy electrical apparatus at Olympia. Among these was a three phase synchronous motor, 10,000 volts 50 periods, of 520b.h.p., direct coupled to a continuous current dynamo of 350kw. at a pressure of 220-240 volts. The motor was of the revolving field type, the field coils being wound for a voltage of 220 volts. During the Exhibition this set was used for generating three phase current at 2,000 volts for driving a haulage gear. To obtain a periodicity of 25 cycles as required by the haulage motor the motor generator was run at half-speed. This was obtained by a reduction of the terminal pressure, a 30kw. booster, which also formed part of the exhibit, being inserted in series with the motor.

Rubber Clothing.—As an insulator for cables india-rubber has met with severe competition from paper and other materials, but for protection to persons handling high voltage apparatus when charged, rubber gloves and mats stand unrivalled. FRANKENBURG AND SONS, LTD., included in their complete and comprehensive exhibits of cables a varied collection of rubber shoes, gloves, mats, &c. They also market a line of waterproofs for tramway employees, the outfit including coats, overalls, leggings, &c.

Car Trucks.—Among the heavier machinery exhibits that of Messrs. MOUNTAIN AND GIBSON, LTD., can be numbered, this company showing full-sized examples of their trucks for heavy and light traction work. An improved pattern is a radial truck, in which the whole weight of the car is supported on rollers mounted on the sub-truck, and working in separate oil baths, the underside of the intermediate frame being fitted with hardened steel rub plates. It is worthy of note that this truck may be used on motor cars or trailers without modification.



PETROL OR GAS ENGINE FOR DRIVING DYNAMOS.
(This was exhibited by the Langdon-Davies Motor Co., Ltd.)

Fire Resisting Cables.—Cables are at all times uninteresting things as exhibits to the common gaze, but there was no lack of interest in Messrs. GLOVER'S fire-resisting cables when tested in the fierce heat of an electric arc. This demonstration was made to illustrate the complete ability of this particular cable to withstand high temperatures. On the same stand were shown leather-braided cables for rough service in mines, yards, and exposed situations.

Dry Batteries, Telephones, &c.

Dry Batteries.—The dry battery, though one of the earliest of cells, has been very slow in developing beyond its former troubles with local action. Despite this failing it has become very popular, and if statistics were available it would doubtless be shown to outnumber the wet form of primary cell in practical use. Attempts have recently been made with cells which are really "dry" at the time of their purchase but are minus the water necessary to moisten the dry electrolyte and set up chemical action. A neat and handy form of this class of cell is known as the Reeplen and was exhibited at the stall of AMALGAMATED DRY BATTERIES, LTD. The cell resembles the usual form of dry battery, but has this distinguishing feature: it may be kept for indefinite periods in hot, cold, damp, or dry climates in a passive condition, and yet on adding a little water it will at once become actively ready for immediate use. From the moment of adding liquid the cell behaves just like those which are "charged" at the time of purchase.

Ignition Dry Cells.—Motorists need no reminding of the stoppages directly traceable to failure of the accumulators furnishing current for their ignition apparatus. Not infrequently breakdowns have been caused by acid leakage and corrosion of terminals and connections. Troubles of this kind must always be expected with accumulators, and until secondary batteries can be dispensed with for the purpose the best alternative is the provision of a light, efficient standby which can always be relied upon. The Reeplen dry cell seems to present all the good features which an alternative electricity source should have, and the fact that it is being extensively taken up for this purpose in the motoring world amply substantiates the claims of the makers for it. A battery of four cells is easily carried on a car and will furnish a heavy current for a considerable period. It can be connected up to an emergency switch so that in case of trouble it is available for immediate service. The cell has the recuperative properties of ordinary dry cells, and will remain active over longer periods, as water can be added to replenish the cell.

A New Battery Jar.—The zinc rod and porous carbon pot in Leclanché cells of the past have displayed a marked affection for each other and their too intimate and frequently constant relationship has given great annoyance to users of bells, telephones, &c. A means for their satisfactory operation in double harness has at length been devised and is being exploited by Amalgamated Dry Batteries, Ltd. It takes the shape of a special jar, with four moulded clips at one corner of the rectangular body, these serving to retain the zinc rod in a vertical position. Its tendency to hobnob with the porous pot is by this simple remedy completely foiled, and its activities will in future be of the chemical rather than the physical order. Like other good servants, it will be kept in its place. The adjoining cut will make the arrangement quite clear and obviate the necessity for further prolixity on our part. While referring to the above-named company we would like to inform our readers that Mr. Chas. Gorick, recently resigned from the General Electric Co., Ltd., has taken up the position of general manager, and will now preside over the commercial destinies of Amalgamated Dry Batteries, Ltd.

National Telephone Co., Ltd.—This company had working in the Exhibition a complete telephonic installation of the latest standard pattern, similar to those at present being fitted in many of the largest hotels and mansions throughout the Metropolis. The distinctive feature may be said to be the use of a central power plant, thus avoiding the necessity of

SPARKING BATTERY,
NEW BATTERY JAR,
REEPLEN DRY CELL.
(Amalgamated Dry Batteries, Ltd.)

fitting separate batteries to each telephone. The lifting of the receiver off the rest gives a signal at the exchange, and the replacing of the receiver again notifies the operator that the conversation is finished, thereby reducing the manipulation on the part of the subscriber to a minimum. Wires radiated from the switchboard to the various stalls throughout the Exhibition, and the switchboard was connected to the company's exchange at Kensington by junction wires, so that each telephone was in communication not only with the other telephones in the building, but with the whole of the Metropolitan exchange system and the trunk system throughout the country.

Hygienic Telephones. — A considerable amount of correspondence has lately appeared in the Press concerning the subject of telephones and disease. The GENERAL ELECTRIC CO., LTD., have for some time been experimenting with a view to producing a telephone which will overcome the objection arising from the common use of an instrument having a mouthpiece which is capable of harbouring germs of disease, and have now succeeded in producing an instrument which serves its purpose in every possible way. In this new instrument, which was exhibited at Olympia, the receiver and transmitter are contained in a small metal case, watch-shaped, which is kept continuously to the ear, both when speaking and listening. There are apertures in this metal case which admit the sound waves, the transmitter being so sensitive that the usual mouthpiece is unnecessary. For the convenience of the user a handle is attached to the case, as will be seen in the illustration. The transmission of sound with this new instrument is in no way impaired, and the very best speaking results are obtained. The advantages will be apparent to everyone, as it is now no longer necessary to have a trumpet, which is at all times likely to become foul and harbour germs of disease, owing to its being in such close proximity with the mouth.

HYGIENIC TELEPHONE.
(G.E.C.).

EXHIBIT OF THE STERLING TELEPHONE AND ELECTRIC CO.
(Telephones for all purposes and any number of stations.)

Representative Telephone Exhibits.—In addition to the firms mentioned on this page a number of telephone manufacturing companies also exhibited and contributed towards making this section of the Exhibition thoroughly representative. The modern telephone is now marketed in types and at prices which bring it within the reach of the most moderate concern, while for domestic purposes also there are systems which can be installed at very low cost. The telephone firms exhibiting were British L. M. Ericson Manufacturing Co., Ltd., The International Electric Co., The Western Electric Co., and Veritys, Ltd.

BRIEF NOTICES OF OTHER EXHIBITORS.

Drake and Gorham, Ltd.—Three stands on which were displayed (1) lighting and heating apparatus, (2) section gas plant and dynamo as used for country installations, and (3) applications of motors to pumping, churning, chaff-cutting, &c.

Dorman and Smith.—Switches and switchgear for direct and alternate currents including the "gap contact" circuit breaker and time limit relay.

D.P. Battery Co., Ltd.—Storage batteries and cells for all purposes.

J. C. Fuller and Son.—The Fuller mercury bichromate battery, as used by the G.P.O. telegraph companies. Ignition apparatus for motor cars and combined gas engine and dynamo set.

McPhail and Simpson's Dry Steam Patents Co., Ltd.—Specimens of superheater tubes and accessories, also parts which have been used for ten years, day and night, on a Babcock and Wilcox boiler.

The Switchgear Co., Ltd—Complete panels for dynamo and feeder switchgear, including an inverse time element for circuit breakers.

Fuller Wenstrom Electrical Manufacturing Co., Ltd.—Specimens of the company's well-known one phase motors and polyphase motors, with patent expanding clutch in pulley by which motors can be started against load.

Hunter Electric Candle Lamp Co., Ltd.—The "Huntalite" patent electric candle with special holders for same. These candles were shown in conjunction with Cooper's patent illuminating cloth mentioned on page 21.

W. Lucy and Co., Ltd.—Iron and brass castings for electrical purposes, especially joint boxes, traction poles, feeder pillars, &c. The company's exhibit of the Frahm speed indicator is referred to on page 21.

The New Bretherton Tube Co., Ltd.—Enamelled steel conduits for interior wiring and steam, gas and water tubes.

Simplified Underground Conductor Co., Ltd.—An interesting exhibit of bare copper mains on insulators in Haskinized wood troughing, and run in with special compound. Tramway feeders, house service boxes, and street lighting switches were also shown.

Selig, Sonnenthal and Company.—Machine tools for every known purpose, including hand tools of latest design, also braiding and winding machines.

A. P. Wright and Company.—Exhibited 16h.p. oil dynamos and fans, the chief feature being the oil engine employed.

Pearson Fire Alarm, Ltd.—A working exhibit showing the operation of automatic fire alarm system exploited by the company.

William McGeoch and Co., Ltd.—Switchboards and fittings for ships' use, also "Duplex" ship indicator and various accessories.

Portable Accumulators, Ltd.—Accumulators of all kinds for every known portable purpose, such as ignition, portable lamps, shot firing, &c.

Sir Hiram Maxim Electrical Co., Ltd.—Display of Maxim incandescent lamps and filaments; also Maxim "Ideal" and "Cristalite" lamps, and a system of continuous lighting by tubular lamps.

Cowans, Ltd.—Circuit breakers for 500-1,000 amps. as used on British battleships, discriminating cut-outs and motor starters, switchboard fuses, rheostats and time limit relays.

The Key Engineering Co., Ltd.—An exhibit of fibre conduit for underground tramway and lighting cables, with socket and screwed joints. Conduit is watertight, acid and alkali proof, non-inflammable when laid, and a perfect insulator. On the same exhibit were shown the "carbone" lamps of the flame type using ordinary carbons.

Spherical Metallic Packing and Engineering Company.—A decided novelty in metallic packing was exhibited by this company, the design being such as to take up automatically all wear, without the aid of links, springs, and other accessories.

Pope's Electric Lamp Company.—An illuminated exhibit of Pope lamps in various patterns including ordinary, fancy, Pope "Ritelite" and patent candle lamps.

B. Dellagana and Co., Ltd.—Exhibit of articles kupronised by special process, these including switch plates, name tablets, fittings, pedestals, &c.

D. Santoni and Co., Ltd.—Intense flame arc lamps for direct and alternate current. An illustration of one of these is given on page 21.

Maple & Co., Ltd.—An attractive and handsome exhibit of choice electric light fittings for gentlemen's houses and mansions, &c. The stand resembled a room in which the various fittings were displayed and illuminated.

Brockie-Pell Arc Lamp, Ltd.—Arc lamps of the enclosed and open types for street and shop window lighting.

British Accumulator Co., Ltd.—A general exhibit of storage batteries and cells for lighting and power purposes. Sections of plates and cells were shown.

The Shannon, Ltd.—Office labour-saving devices and furniture such as letter-filing cabinets, copying machines, card index systems, &c.

J. Defries and Sons, Ltd.—A comprehensive exhibit of Stewart arc lamps, for alternating direct currents, with theatre dimmers, Defresque signs, and field rheostats.

Regina Arc Lamp Manufacturing Company.—Regina arc lamps for burning 300 hours with one pair of carbons at an efficiency of 0.82c.-p. per watt.; also Reginula miniature arcs for a.c. and c.c. circuits burning 40 hours with one pair of carbons.

Ozonair, Ltd.—This company manufactured ozone from the extremely dusty air of the Exhibition, and illustrated the commercial applications of ozone generally.

G. G. Stockall and Sons, Ltd.—Examples of Stockall time recorders, time checking machines, and Shaw Walker vertical filing systems.

Steel, Peach, and Tozer, Ltd.—A speciality is made of the Phœnix liquid controller for motors of all classes, the apparatus being already largely used in steel works, dockyards, &c.

Cory Bros and Co., Ltd.—As large colliery proprietors this company exhibited samples of coal from their numerous mines; the qualities in each particular case being suitable for power stations operating on various loads. See view of stand, page 83.

Cape Asbestos Co., Ltd.—Pipe and boiler coverings of plastic and non-conducting material were exhibited for ordinary and superheated steam purposes. These coverings are removable; also "Capeyt," an improved form of insulator for electrical purposes made up into various articles of standard practice.

The Pyrophone Company.—An interesting exhibit of a new form of fire-detector and alarm. The apparatus is self-testing, and invariably signals any line defects. A false alarm is impossible, and a danger call precedes that of fire. See view of apparatus on page 84.

Klein Engineering Co., Ltd.—An important exhibit of automatic weighing and recording machines, water coolers for natural or forced draught, and a free full steam trap.

Price's Patent Candle Co., Ltd.—An exhibit of lubricants for all electrical purposes; also of apparatus for testing the physical and mechanical properties of oils.

National Gas Engine Co., Ltd.—A fine working exhibit of gas and oil dynamos from 2 to 20b.h.p.; also a suction gas plant and dynamo.

Crossley Bros., Ltd.—An extensive display of gas engines in operation, including high-speed sets direct coupled to dynamos for country house lighting, &c. An oil engine of 4h.p. coupled to a dynamo was also shown.

R. W. Paul.—A complete and comprehensive exhibition of instruments for laboratory and central station use, including galvanometers, potentiometer, and instrument standards.

Crypto Electrical Company.—The best exhibit at Olympia of small charging dynamos, motor generators and alternators. Among the latter was a machine of 2kw. using a new type of "copper carbon" brush. Motor generators were shown for use on alternate or direct current circuits.

Easton Lift Co., Ltd.—A practical exhibit comprising two passenger electric lifts used for conveying passengers to the galleries. A special cross-over drive is employed, and a speed of 150ft. per minute was attained.

Carl Hentschel, Ltd.—An exhibit of specimens from photo-mechanically engraved blocks, which would appeal to manufacturing concerns in the habit of issuing high-class technical catalogues and literature. Blocks made by this process are rich in detail, but lose nothing on that account in quality of tone or depth of perspective.

G. Kaye and Sons, Ltd.—A novelty in locks, which is fitted with electrical release, under control of the housekeeper, and which can be actuated on an alarm of fire being given. Numerous other locks and the Kaye oilcan were also shown.

Marconi's Wireless Telegraph Co., Ltd.—A special exhibit of wireless telegraph apparatus as supplied to the British, Italian, and American Governments. X-ray apparatus and ignition coils were also exhibited. Adjoining the exhibit was a model installation by the MARCONI INTERNATIONAL MARITIME COMMUNICATION CO., LTD., as employed on the Cunard liners and other Atlantic vessels. (See view of stand, page 81.)

Marryat and Place.—This company exhibited the only electric furnace in the building, this being of the Moissan type and designed to operate up to 250h.p. Daily demonstrations of the use of the furnace were given.

Some Representative Exhibits.

Marconi's Wireless Telegraph Co., Ltd., 18, Finch Lane, E.C.
A comprehensive exhibit of ignition coils and X-ray apparatus. Adjoining was a typical Cunard liner installation of wireless telegraph apparatus.

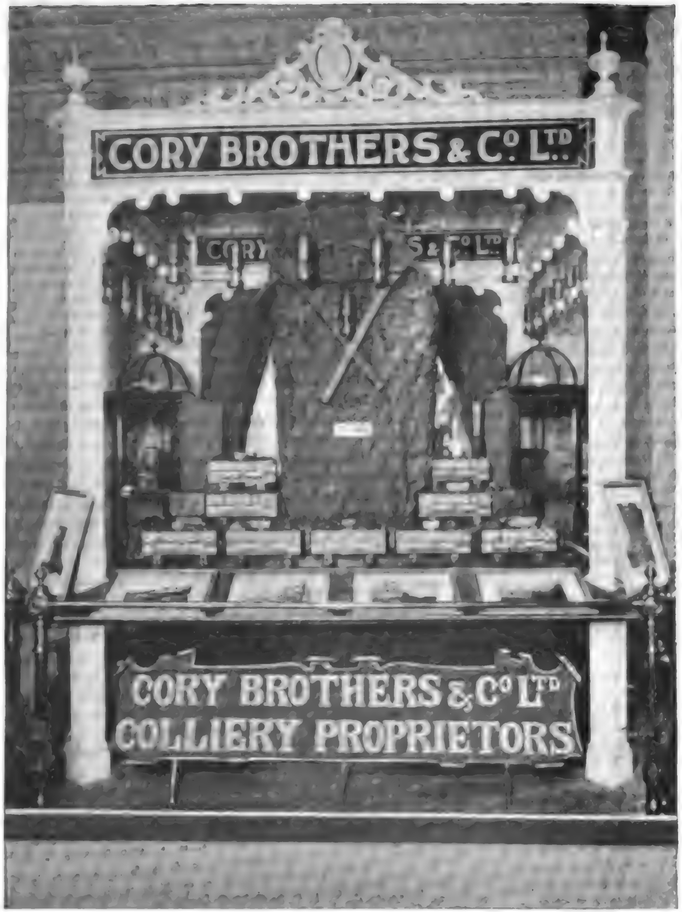
The Sir Hiram Maxim Electrical Co., Ltd.,
Maxim Works, Gillingham Street, London, S.W.

Lister Electric Manufacturing Company, Dursley, Gloucestershire.

A fine display of motors and motor-starters of all kinds. Small-sized motors are fitted with ball bearings, and run very smoothly. A special feature made of a new pattern brush holder which is of the carbon type and adjusts itself to the commutator face.

Sturtevant Engineering Co., Ltd., Queen Victoria Street, E.C.

Specialities in motor-starting devices of every description, solenoid controllers and switches, also lift controllers, fans and blowers for electric motor drive or for belt coupling. Igranic rheostats. (*See* page 45.)

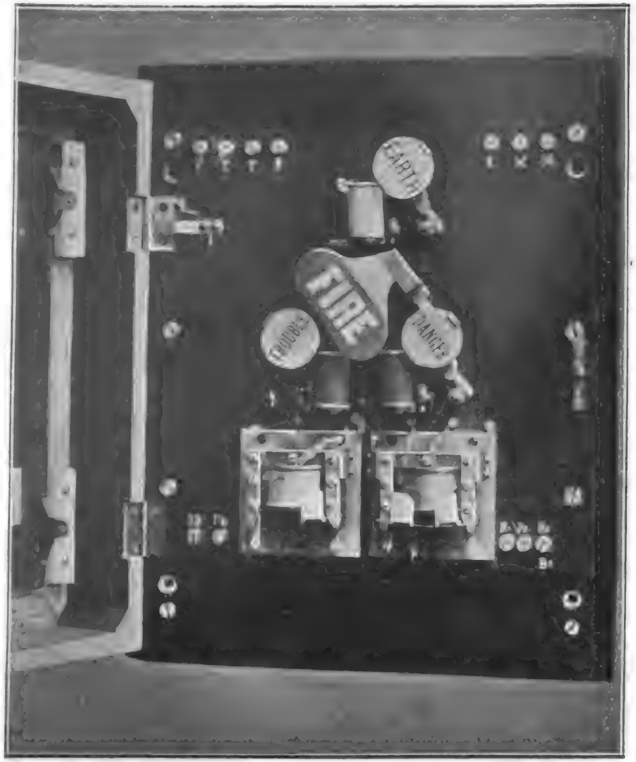


Cory Brothers and Co. Ltd., 3, Fenchurch Avenue, E.C.

A complete exhibit of samples of Welsh coal and other steam-raising coals suitable for power stations, &c.

Arc Lamps, Ltd., 3, Crown Court, Old Broad Street; also The High-speed Braiding Machine Co., Ltd.

A fine display of pure white light with absence of purple rays, on alternating currents. (*See* pp. 20 and 71.)



The Pyrophone Company, 52, Queen Victoria Street, E.C.

View of fire detector and alarm as exhibited by Pyrophone Company. Signals of "Earth," "Trouble," "Danger," and "FIRE" are given, and a very complete protection is the result.

A. Reyrolle & Co., Ltd., Hebburn-on-Tyne.

Practical demonstrations of motor starters with special electricity valve effect. Starting panels, cast-iron wall plugs, oil switches, and fuses for heavy currents and all voltages. (*See* page 42.)

Supplement to The ELECTRICAL MAGAZINE, July, 1905.

Electric Traction Progress & Enterprise.

EMBODYING FULL REPORTS OF THE MUNICIPAL TRAMWAYS ASSOCIATION'S FOURTH ANNUAL CONFERENCE,

AND

THE ELECTRIC TRAMWAYS AND RAILWAYS EXHIBITION.

A Great Industry.—The problem of applying electric power to tractive devices was primarily attacked with such vigour and fixity of purpose that in an astonishingly short space of time a great industry arose as the result of its partial solution. To-day electric traction is a power in the world. In one form or another it is indissolubly associated with the affairs of commercial, social, political, and national life. Indeed, the progress of the world of our time would cease entirely if the reality of rapid transit, as made possible by electrical means, were removed from our midst.

Immense Possibilities.— The present aspect of the art of quickly and economically moving both men and materials from place to place reveals an embryonic condition charged with terrific possibilities. We are on the verge of developments threatening to change completely our outlook on every phase of life. The introduction and exploitation of some revolutionary device may shortly bring drastic changes in our ideas of locomotion. These are no mere figments of the imagination. The enormous influence of rapid transit systems on human affairs in a few years justifies the belief that future methods will bring about even more extraordinary changes.

Car v. Bus.—The electric tramcar, maligned though it is in certain quarters, has conclusively vindicated its position as a highly efficient means of locomotion. The existence of many thousands of miles of line in all parts of the civilised world is evidence enough of its reliability and efficacy. Its wider employment must certainly occasion a redistribution of the population of crowded cities and industrial districts. It has found a place in the affairs of every modern community from which it will be shaken only with great difficulty. The advocates of motor vehicles have endeavoured to bring it into disrepute and cast aspersions upon its efficiency, but the headway gained by the electric tramcar will need all the efforts of its new rival to make up, though it is not yet apparent that any such outcome of a keen competition will transpire in the immediate future.

Suburban Traffic.—The electric train has already ousted the steam locomotive for suburban traffic. Instances of this can be pointed to in all the great cities of the world, more especially in London and New York. The tube lines of the former, and the overhead tracks of the latter, are among the sights of the respective capitals. The immediate future will see the establishment of an electric train service in the suburbs of all great towns, and one of the greatest evils of the steam locomotive, the smoke nuisance, will be thereby eradicated. Railway engineers have been slow to realise that electric traction could become a valuable adjunct to their steam service, but there are not wanting signs of a very rapid change in this opinion. The past year has witnessed the inauguration of electric train service on two British steam railways, and other companies have obtained expert opinion as to the advisability of converting the congested portions of their systems. These are all signs of the times, and point to many years of prosperous activity in the field of suburban electric traction.

Main Line Traction.—Although hopes of the early withdrawal of the steam locomotive from main line train service are not entertained in railway circles, the problem of applying electric power over long stretches of line and conveying that power to rapidly-moving trains is being tackled with the characteristic energy of electrical engineers. The geographical advantages possessed by America, Germany, and Italy, of wide expanses of unpeopled country separating large communities, facilitate the carrying out of high-speed experiments, consequently the bulk of the work in this province is being conducted beyond the borders of the British Empire. Already high voltage electric trains have been put into actual operation with a regular service in the countries mentioned, and every effort is being made to simplify the details both of the power plant, the transmission line, and the train equipment. These experiments, though conducted under different auspices and in countries far distant from each other, are bound to bear fruit before long. There are, in fact, encouraging prospects of considerable activity on a commercial scale in the field of main line electric traction, as the direct outcome of a new epoch in rapid transit methods. This revival will redound to the business advantage of electric railway engineers and the makers of apparatus embraced by the multitudinous details of electric railway systems, for the field of operations is represented by nothing less than the world itself, or the civilised portions of it, and when the work of conversion is fairly begun, many years must elapse before it is completed.

The Fourth Annual Conference of the Municipal Tramways Association.

ON Tuesday morning, July 4th, Mr. J. Allen Baker, M.P., Chairman of the L.C.C. Highways Committee, welcomed the members of the Municipal Tramways Association to London on the occasion of their Fourth Annual Conference, which was held in the Berners Hall of the Agricultural Hall. The proceedings passed off very successfully, though the standard of the meetings did not equal that maintained in previous years. Mr. J. A. Baker, in greeting the Association, referred in pleasing terms to the growth of tramways systems, and especially municipal tramways, and dwelt on the many social advantages of these means of communication, taking the great cities of the world as typical instances.

Mr. A. H. Councillor Bull, J.P., Chairman Reading Tramways Committee.

EXCURSIONS AND ENTERTAINMENTS.

THE Smoking Concert and Conversazione arranged for Tuesday and Wednesday evenings were well attended, and proved quite successful. On Tuesday, after the morning meeting, the members were entertained to luncheon by Mr. J. W. Courtenay, chairman of the Advisory Committee of the Tramways and Railways Exhibition. In the absence of that gentleman, Mr. J. E. Pitcairn presided over what proved to be a very pleasing and enjoyable function. On Wednesday afternoon about fifty members availed themselves of an invitation extended by the L.C.C. to make the trip recently taken by the Prince of Wales when inaugurating the new service of Thames steamers. Amidst delightful weather the party went by river to Greenwich, visited the Council's new power house, now nearing completion, and returned over the South London tramlines, calling at the New Cross carsheds on the way.

On Thursday the members were entirely free to enjoy the excursions which were arranged to Reading and Henley. The weather quite exceeded expectations, and contributed largely to the success of the outing. Mr. Councillor Bull, Chairman of the Reading Corporation Tramways Committee, had lavishly provided for the entertainment of the party. He was ably supported in welcoming the Association to Reading by Mrs. Bull and the Mayor and Mayoress, Mr. and Mrs. J. M. Sutton. After the reception in the Town Hall, luncheon was served in the large banqueting hall, and during the repast music was discoursed by the organist on the large instrument in the building In the absence of the Mayor, Mr. Councillor A. H. Bull, J.P.,

The Municipal Tramways Association at Reading. Outside the Town Hall.

EMBARKING ON THE "ENGLAND" FOR HENLEY.

presided, and after the loyal toasts had been honoured Bailie Alexander, Alderman J W. Martin, the President of the Association. Mr. Hamilton, and Mr. Bull made admirable if lengthy speeches. The party then assembled in the Forbury Gardens, where they were photographed, some subsequently proceeding to the river and embarking on the steamer "England." A very pleasant trip was made to Henley, and although the party arrived somewhat late they were in time to see the sights of a crowded river and the still more crowded banks To many members the trip will be a memorable one, as the regatta at Henley does not coincide with the Association's meetings every year, nor are its members privileged to make an annual visit to the metropolis.

MR. BAKER'S PRESIDENTIAL ADDRESS.

GENTLEMEN.—I have, in the first place, to congratulate the members of our Association on its continued usefulness and prosperity. During the past twelve months many matters affecting tramways and light railways have had consideration, and on more than one occasion we have been able to express our views and to make representations which have been attended with happy results. Our present membership numbers 55 corporations and 82 managers and principal assistants. We represent in capital expenditure upwards of 21 millions of money; our cars run 113 million miles per annum; and we carry more than 1,100 million passengers every year.

The managers' section of our Association, following the usual custom, has during the year held meetings for the discussion of useful and interesting papers on matters pertaining to the operation of tramways.

The meetings this year were, through the kindness of the Lord Mayor, held at the Council House, Birmingham, and the members were very graciously welcomed to the city by Mr. Alderman Beale, J.P., Chairman of the Tramways Committee of the City Council.

Municipalisation in America.

Perhaps the most striking feature of the year, certainly one that has caused most widespread interest in the tramway world, is the announcement that the great city of Chicago has declared by a majority of upwards of 25,000 of its citizens, in favour of the municipalisation of its street railways. It has been a very common thing for the opponents of municipalisation of tramways to point to America in their endeavour to show that better results can be obtained from private than from public enterprise. They have always asserted that the American citizens were far too "'cute" to undertake municipal ownership. Now, no one denies the "'cuteness" of the American, but it must be remembered that civic life in America is comparatively young, and it seems to me to be a sign of national good sense that, as opportunity arises, America is not above taking a lesson from this country. Chicago is a city with an enormous mileage of privately owned lines. It has been estimated that the cost of purchase cannot be less than eight million pounds. The City Council is therefore face to face with the gigantic task of co-ordinating the various systems with a view to

THE SCENE ON THE RIVER AT HENLEY.

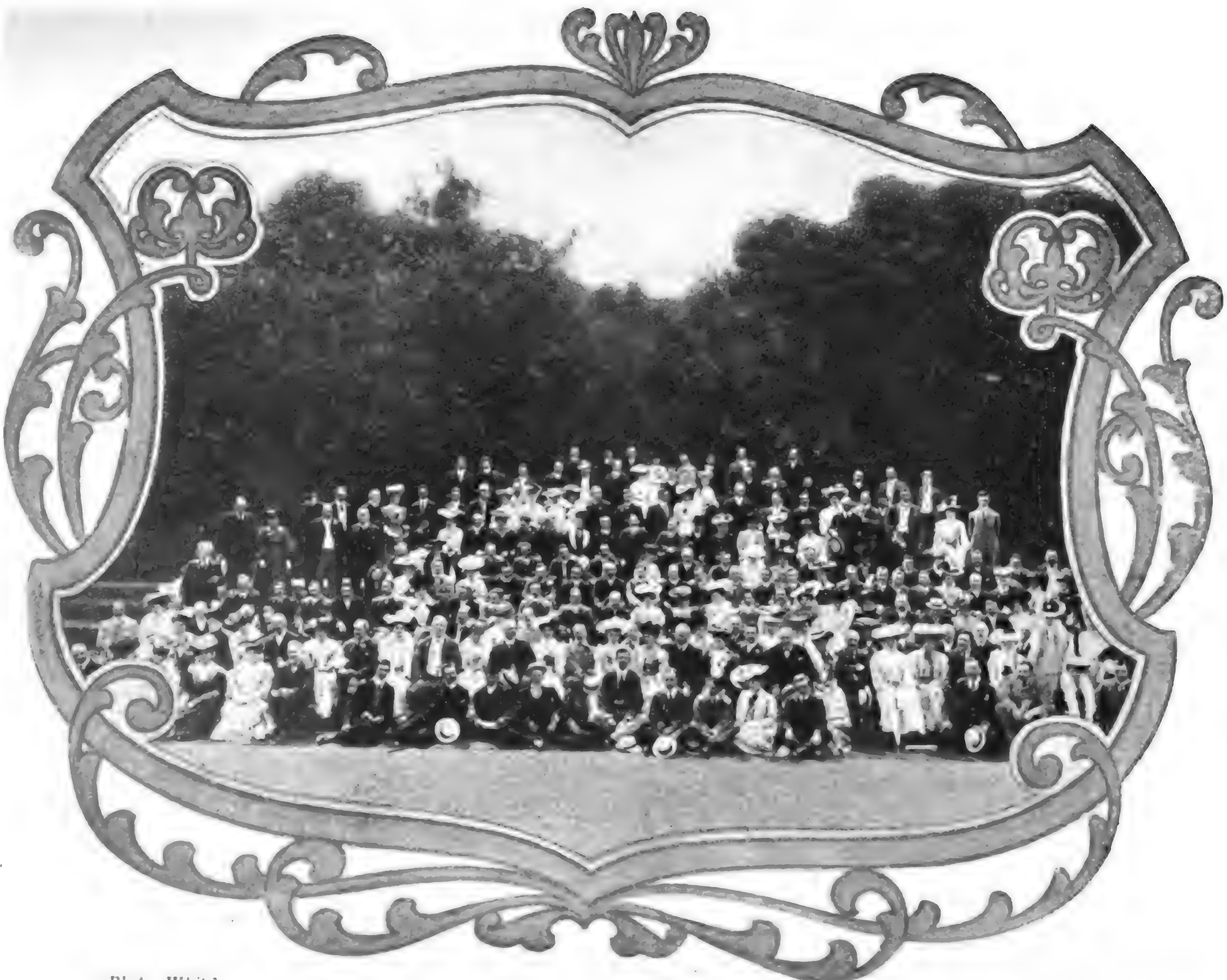


Photo. White]

The Municipal Tramways Association at Reading.

[Reading

giving the city one complete scheme of tramways under proper civic control.

In the early history of electric traction we had to go to America for all our knowledge. It speaks much for the engineering talent of this country that there is now no need to copy the United States any longer. It is generally acknowledged that, as far as the construction and equipment of tramways are concerned, we are not now so far behind—indeed, many people are of opinion that we can give points. However, whether this be so or not, we are grateful for what America has taught us in the past, and if our municipal experience is of any value to Chicago or any other American city, we shall be glad to place it at their disposal in the fullest and freest possible manner. Before passing from this subject, I think we may heartily compliment Glasgow on being invited to teach Chicago something of the art of successful municipal ownership and operation of tramways.

Carriage of General Merchandise.

Those of you who had the good fortune to be present at our annual conference held in Liverpool last year will readily recall the many points touched upon in the presidential address.

Amongst the most striking features of that address was the allusion to the possibility of linking up urban districts with rural districts by means of tramways and light railways for the purpose of general merchandise traffic. This important matter has, I am glad to say, been under the consideration of your executive committee, who, however, are not in a position to lay any proposals before you at the present time.

Parcels on Tramways.

Primarily, tramways are authorised and intended for the carriage of passengers, and it is the first duty of tramway undertakers to give quick, efficient, and cheap services for this purpose. When this has been accomplished to the satisfaction of the community, it seems to me that if another branch can be conducted without interference with the business for which the tramways were originally intended (and this should be the first consideration) the community have a right to demand that their lines shall be used to their fullest capacity in the public interest. That Parliament contemplated the use of tramways for goods as well as passenger traffic is shown by the fact that since the General Tramways Act of 1870 was framed, nearly all the local Acts contained a schedule of charges for goods, parcels, and live animals—even to the donkey. The result of the working in Manchester and Bradford will be watched with the greatest interest by all who are concerned in the operation of tramways, and doubtless many of us will profit by the experience of these go-ahead cities.

Tramway Speeds.

I now come to a subject which has exercised the minds of those engaged in the operation of tramways for a considerable period. I refer to the speed at which cars are allowed to be driven upon tramways.

That the Board of Trade was right in exercising great caution in safeguarding the public when the new system of traction came into vogue no one will deny. As time went on, however, the equipments adopted for properly controlling the cars, both mechanical and electrical, together with the introduction of improved devices for saving the lives of persons falling in front of, or being knocked down by the cars, were of such marked improvement on those at first in use that it was felt the Board of Trade might safely grant increased speed over that originally allowed. Representations were made by the parties interested, and, in some cases, the Board of Trade were induced to grant a slightly increased rate of travelling. It is satisfactory to find that these concessions did not increase the number of accidents occurring in the places where the higher speed had been obtained. In 1903, Liverpool,

MR. A. BAKER, PRESIDENT MUNICIPAL TRAMWAYS ASSOCIATION, 1905: ENGINEER AND MANAGER BIRMINGHAM CORPORATION TRAMWAYS.

with its enormous traffic, was able to demonstrate, after a period of marked immunity from accident, that a higher speed than that allowed under the Board of Trade regulations could be safely granted even in heavy city traffic, and it is satisfactory to know that the Board, after careful enquiry, felt able to give an increase of 25 per cent. over the rate of travelling originally permitted. The general manager of the Liverpool tramways in his annual report states that the broad effect of the change is that while under the old regulations the average speed, including stops, was limited to 5.8 miles per hour, under the new regulations the average speed is increased to about 7½ miles per hour, and that, notwithstanding these changes, street accidents of all classes have considerably declined during the year.

There are many members of our Association who think that much greater facilities might still be granted in this direction, and I confess I am one of their number. When it is remembered that in one year the tramway cars in the United Kingdom ran upwards of 190 million miles, and

that they carried 1,800,000,000 passengers, the number of fatal accidents reported is so small, that this, in itself, would seem a very strong argument in favour of a higher rate of speed. No one, of course, wants to get an authorised speed which it is impossible to make use of in crowded thoroughfares. Here the speed of the cars must to some extent be regulated by the density of the traffic, but in less populous suburban districts it is of the greatest importance that passengers should be transported at a quicker rate than is now permitted.

Motor Omnibuses.

The past year has witnessed what I may call a motor omnibus boom. Opponents of electrical tramways, and especially opponents of municipal tramways, have seen in the coming of the motor omnibus the doom of electrically-driven tramcars. Tramway men have, of course, paid the most careful attention to the motor 'bus to find out whether it was likely to prove a useful adjunct to tramways in dealing with the great mass of traffic requiring to be handled in our great cities, but it did not take long to find out that however useful the motor 'bus may be in some respects, and whatever advantages over a horse omnibus it may have, it cannot now, and never will be able to, compete successfully with an up-to-date electric tramcar.

To quote the Hon. Arthur Stanley, M.P., an ardent automobilist, and president of the Tramways and Light Railways Association. In addressing that Association, Mr. Stanley said :—

"When anyone finds a cheaper mode of traction than a metal wheel on a metal rail, then tramways will be run off the road, but not till then."

There, gentlemen, lies the crux of the whole question, *viz.*, the cost of operation.

Everyone interested in electric traction knows what it costs to operate tramways on a fairly large scale in this country. The figures are published year by year, and are well known even to "the man in the street," but the "boomers" of the motor 'bus are peculiarly reticent as to the working costs of the petrol-driven vehicle. The only figures yet published, so far as I am aware, are those in the weekly edition of the "Tramway and Railway World" for February 7th. These relate to the operation of the Hastings omnibuses, and are set out as follows :—

General Repairs and Tyres ..	3.50
Wages of Conductor and Driver, Washing 'Bus, &c. ..	2.50
Oil, Petrol, Grease, &c. ..	2.00
All other expenses, including depreciation at 20 per cent.	3·50
Total	11.5d. per mile run.

I understand that these figures are stated by the makers, and are not likely therefore to err through excess of caution. It has since been reported in the daily press that the result of a year's working shows a very considerable loss.

Now let us see how these costs compare with electric tramways. Taking six of the largest undertakings in the United Kingdom, I find that the total operating costs average 6.12d. per car mile. This figure includes power costs, traffic costs, maintenance and renewals, and general expenses.

Taking the same six undertakings, the interest and repayment of loans on the permanent way and overhead equipment amount only to another 1.036d. per mile run, so that, taking even this serious item into consideration, there is still a difference in cost of 4.354d. per mile run in favour of electric tramways. It must never be forgotten—and tramway men are not likely to forget—that the cost of operating tramways includes very heavy amounts for rates on the tramway portion of the public road, while omnibuses pay nothing whatever, although they do considerably more damage.

Of course, the principal item of expenditure in connection with motor 'buses is for indiarubber tyres. I am informed on good authority that these cost from 2d. to 2½d. per mile run. Now, assuming a motor omnibus to be capable of running 90 miles a day, the same as an electric tramcar, you have for 365 days a total of 32,850 miles. This means in money for tyres, at 2½d. per mile, £342 3s. 9d. Now, a set of four tramcar wheel tyres can be bought for £8. These will have on an average a life of 50,000 miles, which works out at a minute fraction of a penny per mile—to be accurate .0384d., so that what costs the motor omnibus £342 3s. 9d. per annum, costs the electric car about £5 5s. 1d. per annum. If one takes, therefore, a fairly large city, where, say, 100 vehicles are required in daily service to deal with the traffic, you have a difference in this one item alone of upwards of £33,600 per annum in favour of electric trams.

I think I have said enough to show that motor omnibuses are not going to supersede tramways, and that municipalities and ratepayers need be under no apprehension that the large amount of capital invested in their tramway undertakings is likely to be sacrificed.

Amalgamation.

Another matter which has been freely discussed of late, and one to which your executive committee has given a great deal of attention, is the advisability of amalgamating the three Tramway Associations—*viz.*, our own Association, the Tramways and Light Railways Association, and the Association of Tramway and Light Railway Officials—to form one single powerful organisation, which it is claimed would more adequately represent the views of all those engaged in the tramway industry. You will remember that originally we were formed as a Municipal Tramway Managers' Association. After a short time it was felt to be desirable to alter the constitution so as to embrace chairmen of tramway committees, and a proposal will be before you at a later stage of these proceedings to still further widen the basis of our Association so as to admit vice-chairmen of committees as well as chairmen.

With regard to amalgamating the three Associations, there is much to be said in favour of having only one powerful body to watch over tramway interests, and if satisfactory arrangements can be made I see no objection to it. Municipal interests, however, must not be subordinated, and I, for one, would never be a party to any alteration in our constitution which would tend in the slightest degree in that direction.

The matter, however, is under the consideration of your executive committee, who are giving the most earnest attention to the whole subject.

Informal conferences have already been held with members of the other Associations, but nothing will be done without the full sanction of the members of our Association in general meeting.

Standardisation.

It is true that a great deal of the material now used in the construction and equipment of tramways has been standardised by the British Standardising Committee, and in this respect something like order has been evolved out of chaos.

There is, however, I think, a word of warning due here, lest, following the easy path of standardisation, we should, perhaps unconsciously, stifle initiative and invention. Standardisation up to a certain point is good. It enables manufacturers to stock certain articles which long experience has proved to be in greatest demand. It also enables buyers to purchase, without themselves having to get out special designs, or to pay manufacturers for so doing, and this, of course, is a very considerable convenience. The point I wish to make is this: we must not accept as finality anything that happens to be standard, otherwise our engineers and inventors will become disheartened, and we shall become "sticks in the mud."

CHARGES FOR SUPPLY FROM COMBINED LIGHTING AND TRACTION STATIONS.

By JOHN HALL RIDER, M.Inst.C.E., Electrical Engineer, L.C.C. Tramways.

In 1896, the author read a paper before the Municipal Electrical Association advocating combined lighting and traction stations. The principle was laid down that where the lighting and tramway undertakings were in the hands of the same authority, the supply should be given

J. H. Rider.
[*Block kindly lent by the "Electrical Engineer."*]

to both from the same generating station. There are now about 114 such stations at work, some being originally lighting stations, with tramway plant added, and others, like Plymouth, which was the first, designed especially for the combined supply.

All kinds of objections were formerly raised against combined stations. Engineers who ran lighting plants were supposed to be unfit to be trusted with the supply to a tramway. Tramway work was said to impose such strains upon the machinery that not only was no lighting plant capable of standing them, but also that American-built engines were absolutely essential. In the light of experience these and other myths have disappeared, until practically the only question now left is the most important of all: "Can a combined station sell electrical energy to a tramway as cheaply as the tramway can produce its own?"

In an appendix to this paper are given several tables in which are set out the prices charged for lighting, power, and tramway supply by the various owners of a number of combined stations. It has been difficult to get at the exact figures in many cases, but it is believed that those given are substantially correct.

In some 60 towns the lighting and tramways are owned by the same local authorities, and the prices charged for energy to the tramways departments vary from 2.75d. to 1d., with an average of about 1.62d. per unit. In three cases where the tramways owned by one local authority run into the districts of other local authorities, energy is purchased from the latter at from 2d. to 1d. per unit, and in one case energy is temporarily taken by one local authority from an outside corporation at 1¼d. per unit. Twenty-five corporations supply energy to various tramway companies within their areas at prices varying from 2¼d. to 1d. per unit, with an average of about 1.67d. per unit. On comparing any of these figures with the published returns of local authorities owning separate traction stations, one is at once struck by the apparently low cost at which the latter can work. Out of ten towns the highest cost is given at .86d. per unit and the lowest .34d. per unit, with an average of .515d. per unit. There does not appear to be much room for combined stations after that!

Comparisons, however, are odious, especially when unlike things are compared. The price at which an article can be sold depends upon the entire cost of its production. While the author is bound to acquit those who publish and those who supply the figures for publication of any desire to mislead, yet he must protest against such figures as those just quoted being used to express the "total power costs." They do nothing of the kind. They are merely "works costs," and do not include either rents, rates and taxes, insurance, or any office expenses. Even the addition of these items would not give "total power costs," and we have to include interest, sinking fund, and depreciation (or Reserve Fund) charges before the real cost of the unit is obtained.

When all these have been added, it will be found that in many instances the so-called "total power costs" have been doubled, and the actual cost of production will have been brought

to figures not very different from those at which energy is sold to tramways from a combined station. To show the absurdity of the whole thing, we only have to ask any of the tramway undertakings generating their own electrical energy whether they would be prepared to sell energy at the "total power costs," even with the addition of 10 per cent. as a substantial profit. We have an answer to hand from Glasgow, where, although the (so-called) "total power costs" are only .41d. per unit, 1,243,532 units were sold last year to the electricity department at an average price of 1.47d. per unit.

There is no doubt that in some cases the price charged for tramway energy is too high, but in others it would appear almost as though it were being sold under the real cost. The extremes are reached at Dover (2.75d.) and Bradford (1d.). It is not fair that the tramways should be called upon to pay a high price merely to balance a loss on the lighting undertaking. Neither is it fair to sell under cost to the tramways because a profit happens to be made on the lighting.

It should not be a difficult matter to arrive at a fair basis of charging. Generating electricity for tramways is exactly the same process as generating it for lighting or any other service, and the only difference between the two is that the tramway demand lasts for perhaps 16 hours per day, while the lighting only lasts for an average of about 3 hours.

Generating costs are of two kinds—(*a*) Those which depend only upon the maximum amount of energy demanded; and (*b*) those which depend only upon the number of units generated. The former decide the amount of plant which has to be provided, and therefore, while fixed in actual value for a station of any given size, are lessened per unit in almost direct proportion to the number of units generated. The latter are, practically, a constant value per unit. The one may be called "fixed costs," and the other "running costs."

In "fixed costs" we may include:—

Interest, sinking fund, and depreciation on land, buildings, and plant.

Rents, rates, taxes and insurances.

Salaries and wages at generating station of the stand-by staff required, whether the output be large or small.

Coal, water, &c., required for keeping certain boilers under steam in readiness for "peak" load.

In "running costs" we may include:—

Coal, water, oil, &c., used in running plant under load.

Salaries and wages of staff other than above.

Repairs to plant.

To allocate properly to the lighting and tramway departments their correct shares of the above costs, we have to estimate: (1) The maximum demand in kilowatts of each service (from this we know how much plant to provide for each, including spares, and therefore the "fixed costs" for each service); (2) The approximate output in units per annum taken by each (from this we know how to arrive at the "running costs" for each service).

This is equivalent to saying that the correct charges for supply from combined lighting and traction stations may be obtained by the use of

TABLE 1.—*Lighting and Tramways owned by same Local Authority.*

No.	Town.	Price per Unit for Lighting.	Power.	Tramways.
1	Aberdeen	6d.—2d.	3d.—1d.	1.51d.
2	Ashton...............	3.75d.	1.5d.—1d.	1.5d.—1d.
3	Ayr	5d.	2d.	1.5d.—1d.
4	Barking	4.5d.	3.25d.—1.5d	1.5d.
5	*Bexley..............	6d.	6d.—2d.	——
6	Blackburn	6d.—3d.	1.5d.—1d.	1.5d.
7	Blackpool	7d.—2d.	2.5d.	2d.—1.75d.
8	Bolton	4d.—1d.	2d.—1d.	1.25d.
9	Bournemouth ...	3.5d.—2d.	——	1.683d.
10	Bradford...........	4d.	2d.—1.125d.	1d.
11	Brighton	7d.—1d.	7d.—1d.	1.5d.
12	Burnley	4d.	3d.—1d.	1.56d.
13	Burton..............	6d.—3d.	3d.—1d.	2d.—1.25d.
14	Bury............	5d.—4d.	2.25d.—1d.	1.4d.
15	*Cardiff	7d.—2d.	4d.—1d.	——
16	Chester	4.5d.	2d.—1.25d.	1.75d.
17	Chesterfield	6d.—3d.	1.5d.—1.25d.	1.71d.
18	Colchester	5d.	——	2d.
19	Darlington	4.5d.—3.75d.	2d.—1.5d.	1.75d.
20	Darwen	4.5d.	3d.—2d.	1.71d.
21	Derby	6d.—3d.	3d.—1d.	1.5d.
22	Doncaster	5d.—4.5d.	2d	1.5d.
23	Dover	7d.—3d.	6d.—3d.	2.75d.
24	Dundee	4d.—3d.	2d.	1.49d.
25	East Ham	6d.—2d.	2.5d.	1.75d.
26	Exeter	5d.	2.5d.	1.78d—1.75d
27	Farnworth.........	6.5d.—2.5d.	2.5d.—1d.	1d.
28	Gloucester.........	6d.—2d.	4.5d.—1.5d.	1.25d.
29	Halifax	4d.—3d.	2d.—1d.	1.62d.
30	Ilford	6d.—2d.	7d.—1d.	1.5d.
31	Ilkeston	——	——	1.5d.
32	Ipswich	6d.	2d.	2d.
33	Keighley	7d.—3d.	2.5d.—1.5d.	2d.
34	Kirkcaldy	4.5d.—3d.	2.25d.—1d.	1.75d.
35	Lancaster	5d.	2.5d.	2d.
36	Liverpool	3.75d.—3d.	2d.—1.5d.	1.14d.
37	Lowestoft	7d.—3d.	2.25d.	2.25d.
38	Maidstone	7d.—2d.	2d.—1d.	2d.—1.5d.
39	Manchester	5.5d.	1.8d.—1d.	1.49d.
40	Nelson..............	4.5d.—3d.	2.5d.—2d.	2d.
41	Newport	5.5d.—2d.	2d.—1d.	1.5d.
42	Nottingham	——	——	1.25d.
43	Oldham	4d.—1.5d.	2d.—1.5d.	1.5d.
44	Plymouth	4d.	2.5d.	2d.
45	Rochdale	6d.—2d.	1.5d.—1d.	1.5d.—1d.
46	Rotherham.........	4.5d.—4d.	1.5d.—1d.	1.5d.
47	Salford	3.5d.	2d.—1.5d.	1.89d.
48	Southampton ...	4.5d.	2d.	2.25d.
49	Southend	6d.—4d.	2d.	1.875d.
50	Southport	6d.—2d.	2d.—1.5d.	1.5d.
51	Stockport	5d.—2.5d.	3d.—1.5d.	1.5d.
52	Sunderland	5d.—2.5d.	2.5d.-1.125d.	1.875d.
53	Swindon	5d.	2.5d.—1d.	2.125d.
54	Wallasey...........	5d.—3d.	3d.	1.63d.
55	Walsall	6d.—2d.	2d.—1.25d.	1.76d.
56	Warrington	6d.—3d.	2d.—1d.	2d.—1.5d.
57	West Ham.........	7d.—2d.	5d.—1d.	1.6d.
58	Wigan	5d.—3d.	1d.	1.5d.
59	Wolverhampton	5d.—2d.	2d.—.75d.	1.66d.
60	Yarmouth	6d.—4d.	3.5d.	2.5d.

* Power Station run by Tramways Dept.

TABLE 2.—*Lighting and Tramways owned by different Local Authorities.*

No.	Town. Lighting.	Town. Tramways.	Price per Unit for Lighting.	Power.	Tramways.
1	Aston Manor	Birmingham	6d.—1.5d.	2d.	1.5d.
2	Bootle	Liverpool	6d.—2d.	2d.—1d.	1.5d.—1d.
3	Nelson	Burnley..	4.5d.—3d.	2.5d.—2d.	2d.
4	Shipley	Bradford	4.5d.—2d.	2d.—1d.	1.75d.

TABLE 3.—*Lighting and Tramways owned by same or different Companies.*

No.	Town.	Price per Unit for Lighting.	Power.	Tramways.
1	Camborne	7d.—4d.	4d.—1d.	1.49d.
2	Glossop	4.5d.	4d.—1d.	1.5d.
3	Merthyr	7d.—2.5d.	4.5d.—1.5d.	1.5d.
4	Scarborough	7d.—3d.	2d.	1.4d.
5	Musselburgh	—	—	2d.
6	Stalybridge......	4d.	2d.	1.5d.

TABLE 4.—*Tramways owned by Company; Lighting owned by Local Authority.*

No.	Town.	Price per Unit for Lighting.	Power.	Tramways.
1	Aberdeen	6d.—2d.	3d.—1d.	2.25d.
2	Ashton	3.75d.	1.5d.—1d.	1.5d.—1d.
3	Barnsley	7d.—2d.	1.5d.	1.48d.
4	Barrow	6d.—3d.	3d.—1.5d.	2d.—1.25d.
5	Batley	6d.—2d.	3d.—1d.	1.5d.
6	Birkdale	7d.—2d.	2d.	2d.
7	Carlisle	5d.—4d.	2d.—1.5d.	1.75d.—1.5d.
8	Cheltenham	6d.—3.25d.	6d.—1.5d.	1.9d.
9	Cleckheaton	5d.	2d.	1.5d.
10	Colne	6d.—2d	3d.—1d.	2d.
11	Croydon	7d.—1.5d	2.5d.	2d.
12	Devonport	4.5d.—4d.	—	1.82d.
13	Dewsbury	5.5d.—3.5d.	3d.—1d.	1.5d.
14	Gravesend	7d.—2d.	—	2d.—1.5d.
15	Greenock	6d.—2d.	2.5d—1.5d.	1.2d.
16	Heckmondwike	4d.	2d.	1.9d.
17	Middleton	4d.	2.5d.—1.5d.	1.5d.—1d.
18	Paisley	4d.	2.5d.	2.5d.—1.25d.
19	Peterborough ..	4.5d.—4d.	—	2.15d.
20	St. Anne's	7d.—2d	2.5d.	2d.—1.75d.
21	*St. Helens	4.5d.	2d.—1d.	1d.
22	Taunton	6d.—2d.	2d.	2d.
23	Tynemouth	5d.—2d.	2.5d.—1.25d	1.5d.
24	Worcester	6.5d.—3d.	2.5d.—1d.	2d.—1.75d
25	Wrexham	4.5d.	2d.	2d.

* Plus 10 per cent. per annum on capital expended on plant, feeders, and overhead.

the "maximum demand" system, but it must be properly applied. In the author's opinion there should be one electricity supply department for the town, and it should provide all energy required, and for whatever purpose. It should feed into the overhead wires of the tramway department just as into the wiring of any building, and, as a result of this, it should provide all underground feeder and distributing cables. By adopting the "maximum demand" system of charging, all energy would be fairly supplied on the same terms, whether to tramways, to public lighting, or to private users. But the initial price should be kept high, and for as short a period as possible, while the second price should be kept as low as it was possible to make it. All classes of consumers would then be charged at rates in accordance with their use of the supply, and the "long-hour" demand of the tramways would result in a very low actual price per unit.

To simplify the book-keeping, the tramway demand and output could be calculated at the beginning of each year, and the average price per unit arrived at. Thus, if 8d. per unit prove to be the correct charge for the first hour's supply per day and $\frac{3}{4}$d. per unit afterwards, an average 16-hour tramway load would come out something like—

$$\frac{8\text{d.}+(15\times\frac{3}{4}\text{d.})}{16}=\frac{8+11.25\text{d.}}{16}=\frac{19.25\text{d.}}{16}=1.2\text{d. per unit.}$$

It is difficult to give any opinion as to what the figure really ought to be in each case without knowing all the circumstances. Manifestly, where the tramway demand lasts only 10 hours per day, the cost per unit must be higher than where it lasts 16 hours, as the "fixed costs" would be unaltered. And where coal costs only 6s. per ton the unit must cost less to generate than where coal costs 20s.

It is therefore unreasonable and beside the mark for the tramway department of one town to grumble if it be asked to pay 2d. per unit because another town only charges 1.5d., unless all the circumstances are alike. In the author's opinion, however, the price per unit for a 10-hour tramway load per day should not be more than about one-half, and for a 16-hour tramway load not more than one-third of the average price per unit for a 3-hour lighting supply. If rates higher than these be charged, it will be found in all probability that the tramway department is being asked to bear costs which should belong to the lighting department.

Discussion.

The majority of the speakers joining in the discussion wandered from the point of the paper and cited their individual grievances of charges for traction current. MESSRS. LINSLEY (Salford), MONK (Plymouth), and IVEY (West Ham) dilated in this strain. MR. MCELROY (Manchester) considered the question of combined stations to be a municipal one, and then proceeded to give the charges at Manchester, which coincided in principle to those advocated in the paper. COUNCILLOR FENTON (Sheffield) quoted local conditions of two separate stations, and referred to difficulties for combining them. Then followed MR. TITTENSOR, who could only with difficulty be heard, and ultimately posted himself in front of the assembly. He read copious extracts from a paper he had presented to the I.M.E.A. several years ago, the gist of which was that depreciation should be regarded as "available profit." Experiences at Dundee and Preston gave his opinions of combined and separate stations different aspects, and from the latter he favoured the separate plant. The Preston Corporation, at his advice, refused the local company's offer of $1\frac{1}{16}$d. per unit, built their own station, and came out at .96d. per unit. BAILIE ALEXANDER (Glasgow) believed in one controlling committee and three "subs.," one having charge of the generation of energy, another of the lighting, and the third of the trams. Glasgow's works costs were $\frac{1}{2}$d. per unit, and a peak supply was given the lighting department at $1\frac{1}{2}$d., out of which they made £27,000 profit on the year's supply. MR. LYON (Aberdeen) said the trams were there supplied from a combined plant at $1\frac{1}{2}$d. per unit, or cost price, and MR. H. G. BLAIN followed with figures of separate plants, which MR. RIDER challenged. Mr. Blain, however, had got them from the stations themselves. At West Ham a separate station would have given them a total cost of 1.17d. per unit for a sale of $1\frac{1}{4}$ million units, and 0.94d.

per unit for 2½ million units. ALDERMAN HEY (Halifax) found that charges for lighting went down as soon as trams were supplied from the station; and MR. J. C. SPENCER complimented Mr. Rider on his pluck, though he agreed with his principles in all except depreciation. MESSRS. ROBERTS (Southend) and FISHER (Dundee) pulled the discussion back to the point from which it had hopelessly wandered, the latter especially emphasising that the question was not *do* combined stations, but *can* combined stations supply all services better than separate plants, the prices to be based on the familiar maximum demand system? MR. RIDER had, of course, very little to answer, and contented himself with reiterating the principles laid down in his paper.

RULES AND REGULATIONS FOR TRAMWAY EMPLOYEES.

By H. E. BLAIN (Tramways Manager, County Borough of West Ham).

H. E. BLAIN.

RULES and regulations for employees are a necessary factor in the organization of every tramways undertaking. A cursory glance at tramway methods in this country and America will show that there are two distinct schools of thought in connection with rules and regulations. One type of manager relies mainly upon verbal instructions, together with the regular issue of typed orders. The other type of manager deliberately endeavours to put into plain language the views of the management upon all those matters which experience has shown are of importance in the order and regularity and knowledge which, put together, spell smooth working. Every manager who is worth his salt, however, has got definite ideas on the subject of management which he believes to be vital to the success of his undertaking, and, if these ideas meet with the approval of his committee or directors, it is his duty to endeavour conscientiously to carry them out. The enormous impetus which electric traction has given to local passenger traffic has added importance to all phases of management, and none of these is more vital than the training and control of the employees, who are now numbered in each concern by the hundred, and, here and there, by the thousand. It is essential for the permanent success of a large tramways undertaking that there should be a complete understanding between the management on the one hand and the staff on the other. How is this to be attained? How can the management, the office staff, and the outside employees be helped to work along the same lines, to realise that their ultimate interests are identical, and that only by loyal and genuine co-operation can the best result be obtained? Upon the management lies the first responsibility. Clear and definite instructions upon all general matters: firm but just and even-handed dealing with all derelictions of duty: personal interest in the welfare of the staff—these are the managerial obligations in return for which a willing and cheerful service and a loyal support should be received from the employees. I do not think that instructions can be regarded as clear and definite which are given by word of mouth, probably first to inspectors, and then, through them, to the general staff; nor do I think the practice of frequently sending out typed instructions to be pasted on a depôt notice board is satisfactory. These may, perhaps, be read once, and are probably promptly forgotten, as there is no method of their permanent preservation for individual access. There is also a risk of friction between inspectors and men if the former have to put in force general rules which have not been placed officially before the latter. For these and many other reasons, I regard it as preferable to place in the hands of every employee, on appointment, a printed book of rules applicable to his every-day work, which shall not only tell him how to proceed with his duties, but also put before him the official standard of conduct expected from him as a member of a respectable and self-respecting staff.

I do not claim for our rules at West Ham any exceptional features other than that they represent a careful attempt to codify in simple language, and in as complete a form as possible, the main regulations which should govern the work of the employees in a well-conducted undertaking.

Rules and regulations may be divided as follows:—

A.—General rules applicable to all employees with regard to—

(1.) Terms of engagement.—These should be clearly set forth, and should make it definitely understood that the manager has absolute and final control of the staff, not merely in engaging them, but also in suspension or dismissal. This is especially important in connection with municipal systems. I feel strongly that if a manager cannot be trusted by his committee to deal justly with his staff he is not worthy of their confidence in other ways. There is a printed form of agreement for employment entered into in West Ham which is duly stamped. Employees are paid at a rate per hour.

(2.) Offences regarded as justifying suspension or dismissal. (3.) Care of uniform and cleanliness. (4.) Absence from duty. (5.) Working of road. (6.) Matters directly affecting passengers. (7.) Care of cars, equipment, &c.

B.—Special rules for motormen with regard to—

(8.) Examination and testing of cars.—This should be very carefully attended to, particularly when cars are brought out of the depôt, or are taken over from relief motormen, and serves also as a useful check upon the night overhaul of the cars by the depôt staff. Motormen are paid for 15 minutes prior to commencing duty to report to the inspectors and make this examination.

(9.) Proper method of driving, use of brakes, &c.—Cost of current is an important item in traffic expenses, and material assistance in economy in this respect can be rendered by well-trained motormen, whilst some notable accidents would have been avoided had the brakes been

properly understood and applied. All motormen trained in West Ham are supplied with a small card of cardinal rules for ready reference during their period of instruction or before they become thoroughly experienced.

(10.) Rectification of small irregularities in cars.—Whilst it is unwise for motormen to cause delays to traffic by endeavouring to rectify on the road serious breakdowns, there are many little irregularities which can be localised and put right by a well-trained man.

(11.) Incidents of traffic, such as wilful obstruction, fog, &c.

C.—Special rules for conductors with regard to—

(12.) Orderly condition of cars and equipment, ventilation, &c.—Conductors have a very material influence in determining the comfort or otherwise of their passengers, and should be encouraged in the rules to take a pride in the neatness and proper ventilation of their cars. In connection with this and other matters, I am personally in favour of a bonus system, but I have not been successful in having one established in West Ham.

(13.) Use of punch, tickets, &c., collection of fares, and the paying in of cash, passengers' change, &c. (14.) Offences under bye-laws. (15.) Offences for which persons may be given into custody, and offences for which passengers should be ejected. Assistance which may be obtained from police.

D.—Special instructions with reference to the fall of trolley, telegraph, or telephone wires.—Fatalities coming under this head have not, happily, been numerous, but it is one of the details in connection with an overhead trolley system calling for a carefully worded instruction, and a rule book should give clear information on this point.

It is difficult to treat the subject of rules in a paper of this description, as the points in connection with each matter require setting out for consideration. This is impossible without printing a complete set of rules. I hope, however, sufficient has been said to establish the claims of the subject upon the attention of every manager, and I shall be pleased to hand a copy of our rule book to anyone desiring it.

MOTOR OMNIBUSES v. ELECTRIC TRAMCARS.

By Mr. W. A. LUNTLEY (General Manager, Wolverhampton Corporation Tramways).

W. A. LUNTLEY.

MR. PRESIDENT and GENTLEMEN,—A considerable amount of sensation has been caused during the past few months by the announcement that electric tram cars are doomed, and that motor omnibuses would replace them at an early date; or, perhaps to be more exact, that no more tramways would be laid down, and that the future requirements of the public would be met by the institution of a service of motor omnibuses.

It is necessary to deal with the subject from two aspects:—

First.—With regard to the comparative cost of working these vehicles.

Second.—Whether the travelling public can be catered for as satisfactorily with a motor omnibus as a tramcar.

Dealing with the cost of working the motor omnibus, I may say that I have found considerable difficulty in obtaining figures from places where these 'buses are running. It is therefore impossible for me to give any actual results, but according to experts' opinion, it is generally stated that the total cost of operating a motor 'bus service, including depreciation at about 20 per cent., and all other charges, will be quite 11.5d. per mile. In one town, from which I had some particulars about twelve months ago, the total cost was 1s. 1.6d. per mile, the expense of tyres alone being 4.09d. per mile Compare, then, the cost of operating an electric car service at, say, 9.75d. per car mile, which shows a substantial margin in favour of the latter.

The motor 'bus has not been in existence in our towns a sufficient length of time for an accurate comparison of working costs to be made, but if the expense should be reduced to something near 11d. per mile, it is, in the writer's opinion, not then able to compete with the electric car. One of the principal items of expense appears to be the maintenance and renewals of tyres, which is, in some quarters, estimated at over 2d. per mile.

The cost of petrol is a matter which should perhaps be taken into consideration. Owing to the enormous quantity that is being consumed at the present time, and which will increase considerably in the course of the next twelve months, is it not probable that the price may enhance?

Again, the question of depreciation is one which cannot really be determined at the present stage. The allowance usually made has been 20 per cent., but this figure may have to be increased in course of time with the rough work these 'buses will be called upon to perform.

Apart from the question of costs, it would be well to consider the general working conditions of a motor 'bus as compared with a tramcar. In the first place the average 'bus of a double deck type will only carry 36 passengers (16 inside, 18 on roof, and two beside the driver), as against 52 passengers on a single-truck car, and about 68 for a bogie car. The earning capacity per mile is much less with a motor 'bus, and almost double the number of 'buses would be required to cope with the same traffic.

The reliability of the motor 'bus compared with an electric tramcar is also a debatable point. From one's experience of the latter, the percentage of journeys lost in the course of a year is extremely small; in fact, hardly worth consideration.

An important point presents itself as to whether the motor 'bus can complete a journey in so short a time as a tramcar. In moderately wide streets, and taking an average route in its full length, I am of opinion that the tramcar will have the advantage, chiefly owing to the fact that ordinary street vehicles will keep clear of the track as much as possible.

I do not mean to imply that this rule is altogether carried out, as I have had trouble myself with obstruction cases, but taking into consideration the quick services run in our streets, I do not think there is much to complain of in the matter of obstruction to traffic. The liability of accidents to other vehicles is also a question upon which something may be said, as, although the tramcar is liable to skid on a greasy rail, the motor 'bus may do much more mischief by side-skids, over which there seems to be no control.

In dealing with the motor 'bus as a competitor to a tramway system on main roads, or in connection with busy districts where there is a constant number of people travelling, in the writer's opinion, the tramcar has a decided advantage. The motor 'bus, however, is to be welcomed as an admirable substitute for the horse omnibus on roads where the traffic does not warrant a frequent service, or where the streets are too narrow for a tramway track to be laid down. Also in cities where the tramcar is prohibited in certain streets, these vehicles will become a useful adjunct to a tramways undertaking.

In Wolverhampton we are trying three of these 'buses, but they are not yet in service. These vehicles will be run on a route where there are many hindrances to the laying of a track, and also the important question arises as to the frequency of service required, which is not expected to be more than that of a quarter of an hour. The present accommodation for getting into town from this district is inadequate, and in such cases as these the motor 'bus will certainly become useful.

These 'buses will be accommodated in our present car shed, so that no extra building is required, except the erection of a tank for the storage of petrol. Based on a mileage of 74,000 it is estimated that the approximate cost will be as follows:—

	Cost per 'bus mile. d.	d.
OPERATING CHARGES.		
Petrol	1.5	
Wages of Driver, Conductor, &c. ..	2.5	
,, ,, Oilers and Cleaners ..	.2	
Oil, Grease, and Sundry Stores ..	.2	
Tickets, Light, &c.	.276	4.676
MAINTENANCE AND RENEWALS.		
Tyre Renewals	2.0	
Rolling Stock	.925	2.925
GENERAL COSTS.		
Rates, Insurance, and Miscellaneous ..		.3
		7.901
CAPITAL CHARGES.		
Interest and Depreciation		2.3
		10·201

From the above it will be seen that only the actual charges incidental to the working of these three omnibuses have been taken into account.

Discussion.

The paper contained practically no figures culled from actual experience, consequently there was little or no discussion.

THE BUSINESS MEETING.

Before the papers down for reading on Tuesday were taken the Annual Business Meeting was held. The principal matter for consideration was the amalgamation scheme for effecting the fusion of the Association with the Tramways and Light Railways Association and the Association of Tramway and Light Railway Officials. A joint committee had been formed to report upon the matter, which comprised Messrs. A. Baker and J. M. McElroy, representing the M.T.A., the Hon. Arthur Stanley, with Mr. C. R. Bellamy, representing the T.L.R.A., and Messrs. H. England and G. Conady, representing the A.T.L.R.O. The report of this committee, after setting forth the objects of each Association, had come to the conclusion that in the general interest of tramways one Association only should exist. It then recommended that the Municipal Tramways Association should broaden the basis of its membership, to include representatives of all tramways committees, and that the Tramways and Light Railways Associations and the Association of Light Tramwav and Railway Officials should dissolve their respective Associations. In the discussion the committee's report was strongly upheld by Bailie Alexander (Glasgow), Councillor Fenton (Sheffield), Councillor Smithson (Leeds), Mr. C. R. Bellamy, Mr. Hall, Mr. McElroy, Mr. Fearnley, Alderman Hay (Halifax). An amendment, however, was proposed by Mr. Wainwright, Vice-Chairman of the Manchester Corporation Tramways Committee, that the matter be referred back to the Executive Committee, and that in the meantime all the members of the Association should be informed.

J. B. HAMILTON (PRESIDENT, M.T.A., 1905-6).

This amendment was put forward in the interests of the Association and of the smaller towns which many of its members represented. It was feared that amalgamation with the other Associations would subserve municipal interests to those of private companies. Messrs. Everson (Plymouth), Pearson (Birkenhead), Larard (Hull), supported the amendment, expressing their views more or less at length; while Messrs. Lancaster, Mozley, Fraser, and Tittensor also briefly expressed dissent from the report. In the ballot the amendment to refer the matter back was supported by the majority of the members.

The election of officers for next year was then proceeded to, and Mr. J. B. Hamilton, General Manager of the Leeds Corporation Tramways, was unanimously elected President for the coming year. Mr. Councillor Boyle, Chairman of the Manchester Corporation Tramways Committee, was unanimously elected Vice-President, and Messrs. A. C. Fell, J. Dalrymple, P. Fisher, and C. J. Spencer were elected to fill four vacancies on the Committee.

The Third International ELECTRIC TRAMWAY & RAILWAY EXHIBITION.

SINCE the first and second of these exhibitions were held in 1900 and 1902, electric tramway matters have assumed definite practical shape, while electric railway affairs may still be said to be in an amorphous condition. The third exhibition, promoted by the zeal of our enterprising contemporary the *Tramway and Railway World* was opened by Lord Derby at the Agricultural Hall on July 3rd, and the character and extent of the tramway exhibits and the comparative scarcity of heavy electric railway apparatus fully justify our opening remarks. The exhibition was the best possible answer to carping critics of the stability of electric tramway industries, and in no better manner could the opponents of tramways have been met by practical evidences of the virility of this important form of locomotion. The figures given by Lord Derby at the inaugural luncheon, indicating the extraordinary development of electric tramways, were a fitting introduction to an exhibition of apparatus which confirmed and substantiated his statistics in every respect. Other speakers at the luncheon included Mr. R. Millar, general manager of the Caledonian Railway; Councillor Flint, Leicester Corporation Tramways; Bailie Alexander, Glasgow Tramways; the Hon. Arthur Stanley, M.P., President of the Tramways and Light Railways Association; Mr. A. Baker, President of the Municipal Tramways Association; Alderman F. Smith, Liverpool Tramways; Sir Guildford Molesworth, President of the Institution of Civil Engineers; Mr. C. R. Bellamy, Liverpool Corporation Tramways; and Mr. J. W. Courtenay, Chairman of the Exhibition; and they all in various ways spoke of the improved prospects of tramway developments—quite regardless of a wave of prejudice which would shortly give place to an even stronger impulse of popularity for tramway enterprise generally.

Motor omnibuses and railway motor cars were naturally given places in the exhibition, attracting both the inquisitive and the interested. Of the former vehicles the tramway manager has possibly mixed feelings of contempt and patronising regard. He either thinks the motor omnibus is no direct competitor of his tramcars or he regards it as a valuable adjunct to his system for bringing up passengers from outlying districts. The railway motor car is an interesting development of the tram and automobile, and enterprising railway companies having an eye to economy are taking full advantage of these handy vehicles for the lighter services of their small lines.

From all points of view of design and construction the third Tramway Exhibition may be voted a complete success. Its promoters are to be congratulated on the splendid and varied character of the exhibits, and the tramway industry may pride itself on getting so magnificent an opportunity to vindicate its position as a typical example of what British enterprise and capital can do in tramway circles.

THE OPENING CEREMONY BY LORD DERBY.
(By kind permission o the "Tramway and Railway World.")

THE INAUGURAL LUNCHEON IN THE AGRICULTURAL HALL.
(By kind permission of the "Tramway and Railway World.")

GENERAL VIEW OF EXHIBITS AT THE ELECTRIC TRAMWAYS AND RAILWAYS EXHIBITION.
(By kind permission of the "Tramway and Railway World.")

EXHIBIT OF BRUCE PEEBLES and CO., LTD.

FROM the point of view of novelty the exhibit of Messrs. Bruce Peebles and Co., Ltd., East Pilton, Edinburgh, certainly took first place, especially as among other things they were showing an example of the much discussed one-phase motor. They are also licencees for the manufacture of three-phase railway apparatus under the patents held by Messrs. Ganz, of Buda Pest; they have at present in hand two railway schemes in which such apparatus is to be utilised, one of these being the Portmadoc, Beddgelert, and South Snowdon Railway, which forms part of the enterprise of the North Wales Power and Traction Co., Ltd.; and the other a standard gauge Inter-Urban Railway in Canada, in the State of Ontario, some thirty miles in length.

The North Wales line is a light railway, the gauge being only 2ft., and its purpose is to convey on the one hand visitors and tourists from Portmadoc, or ultimately from Carnarvon, to the districts surrounding Snowdon; and on the other hand to provide more advantageous means of transport for stone from the many quarries in the district down to Portmadoc for shipment. There will be two overhead conductors for each line of track, the rails serving as the third; and the voltage between the conductors is to be 600.

The locomotives, of 10 tons weight each, are equipped with three-phase motors of the slip-ring type, having vertical shafts, and are controlled by rheostats practically identical to those which have been working successfully for nearly three years on the Valtellina line. The locomotives are sufficiently powerful to draw fifty ton loads on gradients of 1 in 40, and the maximum speed is about twenty miles an hour.

Current for driving the trains, and also for use in the various industries of the neighbourhood, is generated at a hydro-electric power station, in which an initial plant consisting of four 1,500kw. Peebles turbine driven high-tension three-phase alternators are now being erected. These alternators generate current direct at 10,000 volts three-phase, which is the transmission voltage. The great bulk of the transmission will be carried out on the overhead principle on poles. But for the liberal and enlightened attitude of the Board of Trade with regard to the question of transmission for this overhead work, the scheme would certainly have been commercially impossible, as the centres of population in the North Wales district are so far apart that the expense of underground mains would have been prohibitive.

The Canadian Railway, which is the property of the South-Western Traction Company of Canada, extends from the city of London, Ontario, Canada, in a south-west direction to Lambeth, and thence in a southerly direction to St. Thomas and Port Stanley, with branch line to Lambeth and Delaware.

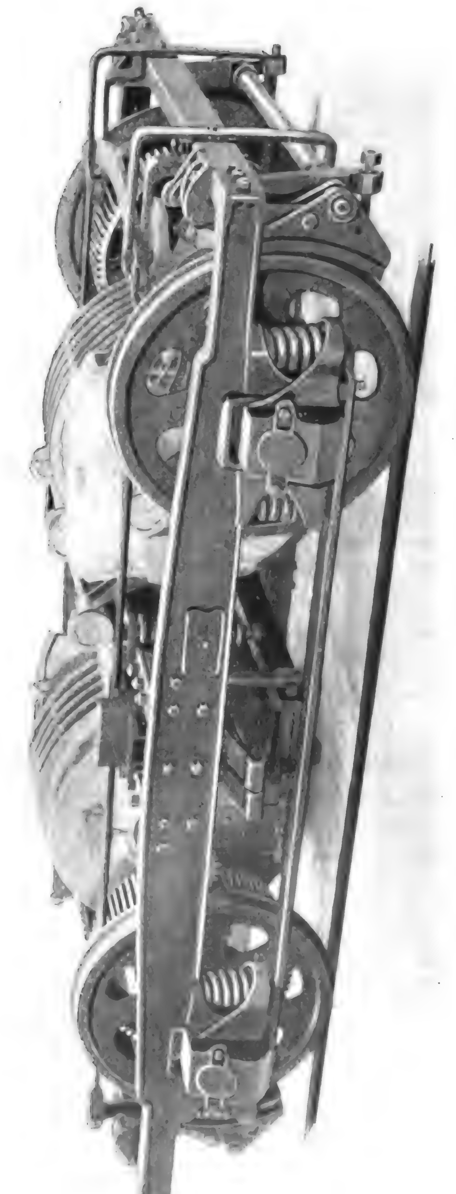
The entire contract, from power house to cars and track, is being executed by Messrs. Bruce Peebles, as main contractors. The power plant will consist at first of three units of 500h.p. each, the engines being of the Browett-Lindley type driving Peebles three-phase 10,000 volt alternators at 375 revolutions per minute. The current will be transmitted at 10,000 volts 25 periods to substations along the line, at which it will be stepped down to 1,000 volts for supply to the cars. As in the case of the North Wales equipment there will be two overhead lines, the track serving as third feeder.

The cars, of which there will be ten, will each be equipped with two 135h.p. patent duplex motors, capable of operating either three-phase current at 1,000 volts, or upon continuous current at 500 volts. The special reason for this duplex equipment is that the street railways of the city of London are operated upon the standard 500 volt d.c. overhead system, and it was considered desirable that the inter-urban cars should run straight to the terminus at the centre of the city of London. It will be seen, therefore, that the three-phase traction motor fully shares the advantage of the single phase traction motor of being able to run alternatively upon continuous or alternating current.

As high speeds up to forty-five miles an hour or more will be attained on this line, Westinghouse air brakes have been fitted.

The work is proceeding very rapidly and it is probable that at an early date some of the cars at least will be running.

Undoubtedly one of the leading problems for electrical engineers at the present day is



BRUCE PEEBLES TRACTION TRUCK WITH DUPLEX MOTORS (THREE PHASE—CONTINUOUS CURRENT).

the adaptation of electric motor power to railway work. That this problem has received the fullest attention from Messrs. Bruce Peebles will be obvious from the fact that they have manufactured not less than four distinct types of equipment for traction, *viz.*:

Standard series continuous current motors.

Three-phase motors, with cascade or other method of control.

Duplex three-phase and continuous current motors.

Single phase motors.

The single phase motor, an example of which was shown at the Tramways Exhibition, is of the compensated repulsion type, constructed under the Peebles Arnold-La Cour patents. In principle this motor more resembles the motor invented by M. Latour than any of the other single phase motors on the market, but it has the advantage of requiring three brushes only instead of four for a bi-polar arrangement of the field. As the armature of this motor is series wound, it is, of course, possible to utilise the same number of brushes, *viz.*, three, for any number of poles. In the particular motor, however, which was shown at the Tramways Exhibition five brushes have been used, four of which were short-circuited on each other, as in the Latour arrangement, the other one being simply used to lead in the current direct.

The decision to use five instead of three brushes was prompted only by considerations of current density in the short circuited brushes, as had three brushes only been used it would have been advisable to make the commutator of slightly greater length, which is, of course, inconvenient in a traction motor. The motor shown at the exhibition is capable of an output of 80h.p.; the power factor is almost unity throughout the range of loads, and efficiency nearly the same as that of a continuous current motor of corresponding output. The stator has a distributed winding similar to that of an induction motor, while the armature is of exactly similar construction to an ordinary continuous current armature, no special high resistance leads to avoid sparking at the commutator being required in this type of motor. The air gap is 3 mm.

Attention may be called in passing to the flame arc lamps which Messrs. Bruce Peebles exhibited, and for which they claim a photometric efficiency of approximately three times that of a standard continuous current arc lamp with vertical carbons. A noticeable point of these lamps is that the distressing flickering which was so grave a defect of the earlier flame arc lamps is quite absent. Several lamps were burning on the stand, and attracted considerable attention, as well as giving full prominence to the exhibits at night.

NEW THINGS IN CAR TRUCKS.

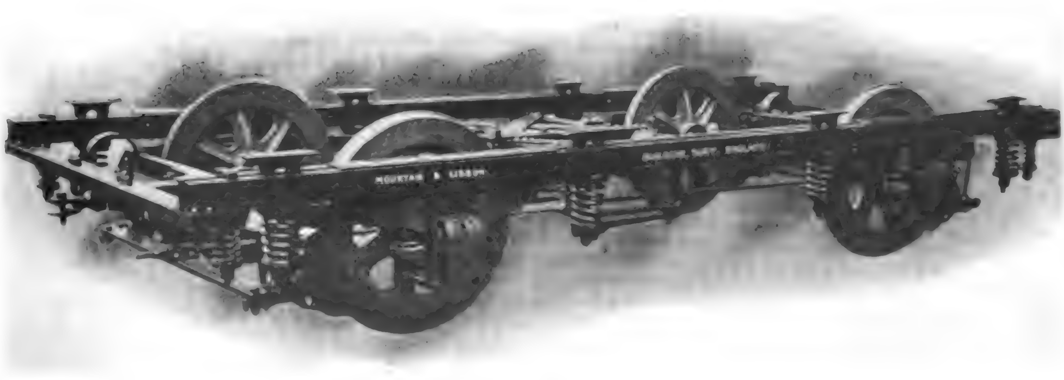
Mountain and Gibson, Ltd.

A HANDSOME and attractive stand at the exhibition was that of Messrs. Mountain and Gibson, Elton Fold Works, Bury, there being several unique features about their specialities in car trucks and trolley standards. Prominent among these we noticed the "M.G." No. 21 E.M. four wheel electric tramway motor truck of standard design built for a track 4ft. 8½in. gauge with a wheel base of 6ft. The side frames are of solid forged steel, the axle boxes are dust proof and and are of steel fitted with bronze journal bearings and keep plates, the journals being 3¾in. diameter. The car body is supported on eight spiral springs, and four three-quarter elliptic springs, all carried upon side frames. The spiral springs are of special form with bases of enlarged diameter to give as great a bearing as possible, and prevent rolling of the car. The motor suspension arrangement consists of two crossbeams carried at either end upon spiral springs; recoil springs are also fitted to prevent jar upon the motors. The truck is fitted with steel tyred wheels 31¾in. diameter on tread, the steel tyres being of a section to give a guaranteed running of 50,000 miles without renewal. The wheels are mounted upon steel axles of special quality, 4in. diameter in body, and are forced on the axles to required position by hydraulic pressure.

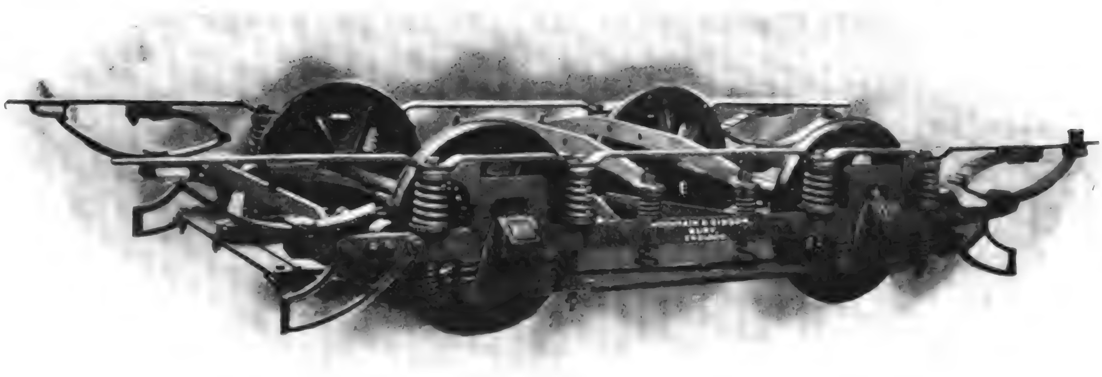
The brake rigging is of the equalising bar type with a brake block working upon each wheel and so arranged that under all conditions the brake blocks bear equally upon all four wheels; the tension can be easily adjusted and the brake block holders are so hung as to allow the brake blocks to accommodate themselves to the wheels as the tyres become reduced through wear.

There was also on view an "M.G." four wheel radial electric tramway truck, built either for use as a motor or a trailer truck, for a track 4ft. 8½in. gauge and with a wheel base of 8ft. 6in. The truck is designed to run easily on sharp curves with the least possible friction and wear on the wheel tyres. The arrangement comprises an intermediate frame composed of steel channels with centre stiffeners and braces, to which are fitted king pins forming the pivotal points from which two subtrucks radiate. The weight of the car body is taken by the intermediate frame, which is supported by an arrangement of rollers mounted upon the subtrucks working in separate oil baths, the under side of the intermediate frames being fitted with hardened steel rub plates working upon the rollers. The truck exhibited was a trailer truck.

On the same stand was an "M.G." type "L.C." adjustable traction truck for bogie car. This is a standard truck of the side-bearing type built for a track of 4ft. 8½in. gauge and with a wheel base of 4ft. The truck is constructed for carrying one motor, and the motor suspension bar has both compression and recoil springs at either end. All parts of the truck are easily accessible, and the truck has been built for lightness in weight consistent with strength.



MOUNTAIN AND GIBSON'S NEW RADIAL TRUCK.

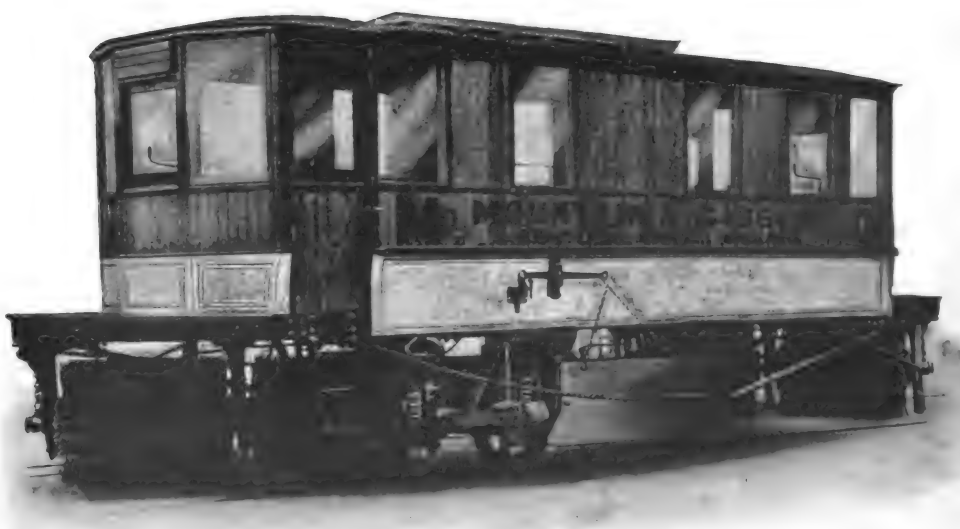


Mountain and Gibson's Four-wheel Electric Tramcar Truck.

A "M.G." type "F" bogie truck built for electric tramcars was also shown. This truck is intended for use with heavy cars, in which four motors are employed. It is of the swing bolster type with centre bearings for car, is built for a track 4ft. 8½in. gauge, with a wheel base of 6ft. The side-frames are of solid forged steel, the motors are outside hung, the end sills are shaped to suit, and fitted with motor suspension, with compression and recoil springs at either end. The axle boxes are of cast iron, dust proof, and have spiral cushion springs placed over them. The bolster upon which the car body rests is fitted with swinging links and also with elliptic and spiral springs mechanically proportioned. The wheel base of this truck is very short, and the truck is so built as to enable the body to be carried as low as on a single truck, adapting it especially where high speed and heavy service are required.

The "M.G." improved trolley for double deck cars attracted considerable attention, as did also the "M.G." improved trolley for single deck or canopy cars.

Several "M.G." improved simplex life-guards were to be seen, and among the specialities of Messrs. Mountain and Gibson was a line of track sweeping and watering cars, which are very extensively used.



Track Sweeper built by Mountain and Gibson, Ltd.

MECHANICAL STOKER ECONOMICS.

Messrs. Ed. Bennis and Company, Little Hulton, Bolton.

Right away from the time of James Watt until our own days—specially our own days—go-ahead engineers all over the civilised world have made ceaseless efforts to produce cheap steam with smokeless chimneys, and to secure the utmost economy in the utilisation of energy. Whilst we admit that not even the most hopeful inventor can claim for his apparatus that it fulfils ideal conditions, yet excellent results can be and are being obtained, and these frequently under the most adverse conditions.

He would be an extraordinary man indeed who looked upon the average boiler as an ideal apparatus for the economical generation of steam. Let that boiler be fired with praiseworthy carefulness and incontestable skill, yet the performance of obtaining the highest calorific value from the fuel used is one which can only be carried out under laboratory conditions.

The ideal stoker should—

(1) Increase the economy in fuel when compared with hand-firing.

(2) Secure a smokeless furnace even with bituminous coal.

(3) Have few wearing parts.

(4) Possess reliability.

(5) Be self-contained.

(6) Incur small capital cost.

(7) Require small maintenance cost.

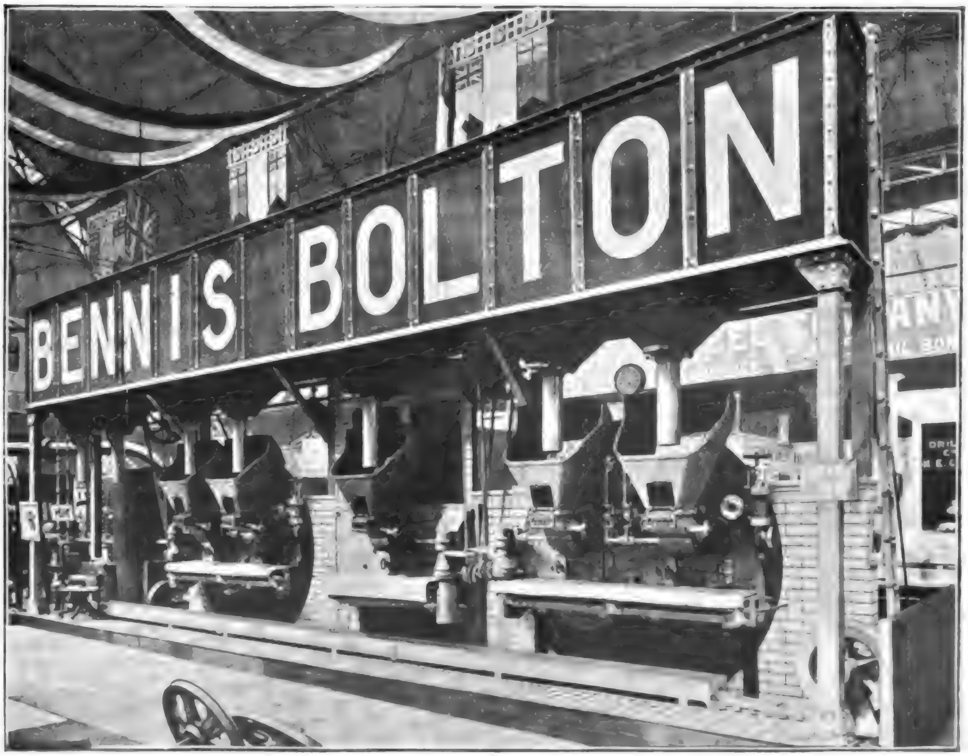
(8) Be provided with an adjustable feed.

(9) Be worked at small running cost.

(10) Be automatic in action.

Now all these main-line requirements of an ideal stoker are fully met with in the Bennis patent gold medal machine stoker fitted with patent pneumatic gear and self-cleaning compressed air furnace, which occupied a commanding position at the Tramways and Railways Exhibition.

The exhibit showed a complete installation



Front View, Bennis Exhibit, showing Overhead Coal Storage Bunkers.

of overhead coal storage bunkers as applied to a range of boilers. The bunkers are fitted with taper hopper bottoms as supplied to many of the leading firms of this country and abroad, and the coal is fed to the overhead coal bunkers by the Bennis system of elevating and conveying plant.

The exhibit showed the Bennis steel chain conveyor, consisting of special Siemens-Martin mild steel chain running in a substantial hard cast-iron trough, the simplest and strongest conveyor for dealing with coal or ash, or both, and the most efficient. The coal conveyor runs along the top of the coal bunkers, and is arranged to feed any portion that may be desired of them. The return chain is used for conveying the ashes from the boilers.

These well-known stokers and furnaces of the company were shown in operation applied to Lancashire and water tube boilers. The coal is supplied to the fire intermittently in very small quantities, each time on to a different part of the fire, the amount of feed being controlled by a simple adjustable cam on the right hand side of each stoker. The self-cleaning furnace exhibited was of the Bennis patent compressed air type, which enables the supply of air to be adjusted with exactitude to the evaporative requirements of the boiler. The furnace is so arranged that the wearing parts are practically everlasting.

The Bennis stokers and furnaces have been adopted by the British Admiralty for their power stations, and by the leading electricity and tramway stations in the United Kingdom. They hold the record for the lowest coal costs, and are the only machines that enable the boilers to meet the peak of the load.

Illustrations of the Bennis and Miller-Bennett patent revolving chain-grate stoker, were for the first time shown. It has many advantages over any existing chain-grates, as knuckle joints are used instead of the ordinary joints of present practice, thus doing away with all excess of cold air where it is not wanted, and ensuring economic combustion. Most excellent results have been obtained with this grate at the Kensington and Notting Hill electricity station.

The exhibit also included the well-known Darling calorimeter, the simplest device of the kind in the market. The results obtained by this instrument are as accurate as with the expensive Bomb calorimeters.

For those of our readers who are interested in a more detailed description of the Bennis stoker and furnace we append the following particulars of its construction and design. In this machine small fuel or slack is thrown by hand or fed by mechanical means into a stoker hopper of about 3cwt. capacity, of which there are two to each Lancashire boiler.

Under the hopper is a cast-iron feeding box, in the interior of which there is a simple pusher plate with an adjustable reciprocating motion. The fuel falls in front of the pusher plate, and is pushed, by its movement, over a ledge formed by the bottom of the feeding box. The weight of the fuel so pushed over is regulated by means of an adjustable cam on to the driving shaft, so that the rate of feed can be seen by noting the position of the cam. The simple motion of turning a hand-nut, whilst the machine is running, enables the coal feed to be graduated from nothing to a ton per hour.

The fuel thus pushed over falls on to a flat plate called the shovel box, from which it is projected into the fire at intervals by an angular shovel, being effectually scattered over different portions of the grate. The shovel is actuated by a patent pneumatic gear. This consists of a long coiled spring enclosed in a cylinder and pressing on a piston, the spring being used merely to propel the shovel forward, an air cushion thus absorbing all shock and making a practically noiseless machine. The cam which draws back the shovel has four varying lifts, the effects of this motion being to scatter the fuel on the fire in four divisions, each about 18in. long, so that in a 6ft. furnace the fuel is thrown on only a quarter of the fire at once, a most material point where smokelessness is important, giving time for each portion of the fire to become incandescent between its charge.

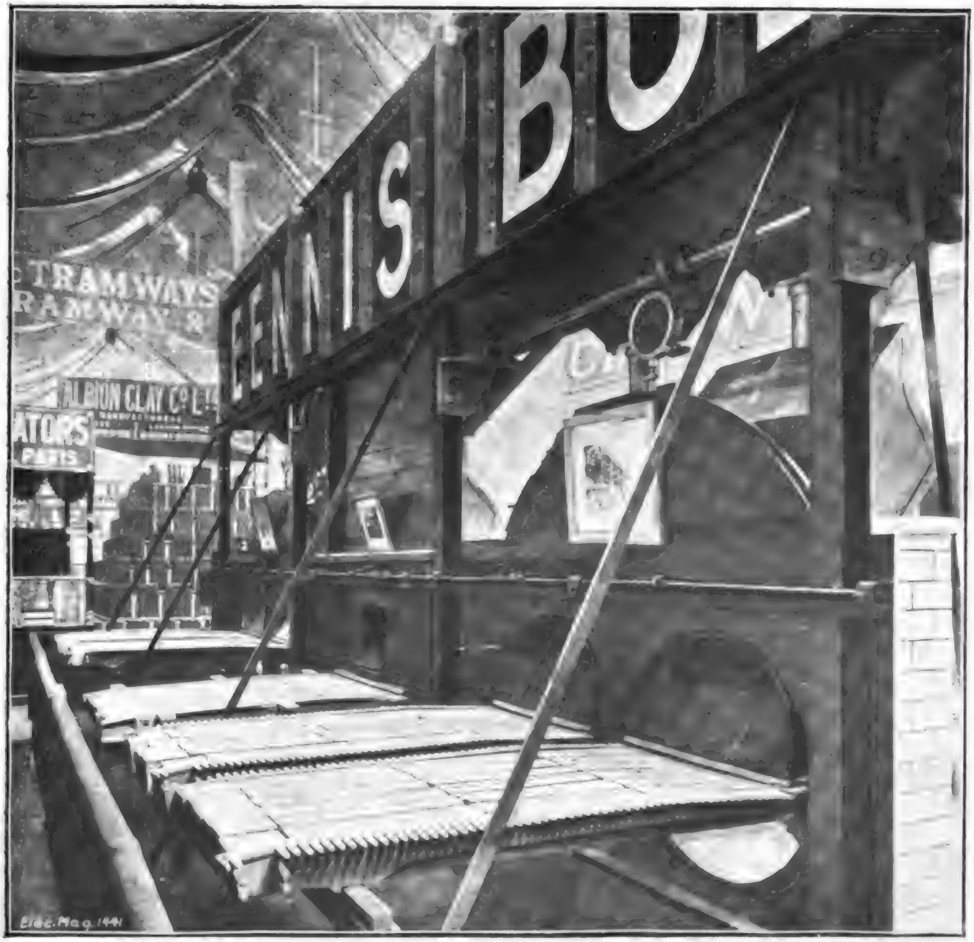
When using low class or waste fuels, which generally contain a large proportion of clinker and ash, the air spaces in the fire bars of ordinary furnaces soon become more or less covered or stopped up, and the fire suffers in consequence.

It is manifestly impossible to adjust the supply of air to the fire to consume the fuel perfectly, unless the clinker and ash are continually removed. In the "Bennis" patent self-cleaning compressed air furnace this is effectually accomplished. This consists of tubular fire troughs of the length the grate is intended to be. The upper surface of each fire trough consists of small interlocking grate

bars in about 2ft. lengths, upon which the fire rests.

The fire troughs all move into the fire together about 2in. and are then drawn out by means of 4in. cams on a transverse shaft. These cams are made the full width of the troughs, so that there is scarcely any wear upon them; and so powerful is the self-cleaning action, that in travelling from the front of the fire to the back, the coal ascends an incline of more than 3in. The clinker and ash are slowly carried forward by this action to the end of the bars, where it drops over into a closed chamber, giving up its heat to the boiler, and is drawn out about once or twice every day.

The air spaces between the bars being always free and open, and each tubular fire trough having its own supply of air, fed by a minute steam jet, the draught is evenly distributed over the whole fire grate, and the boiler continues to do its work even while cleaning out the clinker from the chamber, while the fire being always clean is ready to have sudden calls for steam made upon it, and by turning on the blowers full the rate of combustion can be enormously increased. We propose to deal at some length in an approaching issue with the Miller and Bennett Chain-Grate Stoker, which is manufactured exclusively by Messrs. Ed. Bennis & Co., Ltd., who have the exclusive rights of manufacture and sale.



Rear View of Bennis Exhibit at the Tramways and Railways Exhibition.

TRACTION ENTERPRISE OF J. G. WHITE & CO., Ltd.

SINCE the last Tramways and Railways Exhibition of July, 1902, Messrs. J. G. White and Co., Ltd., have completed many important tramway contracts. The most interesting of these was the Amsterdam-Haarlem Electric Railway, the Kalgoorlie power and electric lighting plant, and the conversion of the Brixton and Streatham Cable Line to electric traction on the conduit system.

The following list shows the work completed by Messrs. J. G. White since the last tramway exhibition :

Auckland (N.Z.) Electric Tramways		£375,000
Aberdeen Suburban Tramways (complete construction) ...		35,000
Amsterdam-Haarlem (Holland) Electric Railway (complete construction) ...		300,000
Bombay (India) Lighting ...		36,000
Bournemouth (Hants) Corporation Electric Tramways		162,000
Bexley Heath (Kent) Electric Tramways		16,500
Barnsley (Yorks) Electric Tramways		29,000
Colchester Corporation Electric Tramways (complete construction)		35,000
Darlington (Yorks) Corporation Electric Tramways ...		39,000
Derby Corporation Tramways (complete construction) ...		95,000
Gloucester Corporation Electric Tramways		5,000
Havana (Cuba) Lighting ...		20,000
Kalgoorlie (W.A.) Electric Power and Lighting Plant		150,000
Kalgoorlie (W.A.) Electric Tramways (supplying machinery, material, and rolling stock)		60,000
Lille (France) Tramways ...		60,000
London County Council Tramways:		
Tooting Section, conduit, ducts, ploughs,	£195,000	
Camberwell Lines	60,000	
Peckham Lines	110,000	
Queen's Road Widening	1,200	
St. John Street Improvement	4,000	
Brixton-Streatham Cable	95,000	
Camberwell New Road Widening, &c.	3,000	
		468,200
Mid-Yorkshire (Shipley) Electric Tramways (complete construction)		£55,000
Middlesex County Council: Cricklewood and Edgware Section permanent way		50,000
Northampton Corporation Electric Tramways		42,000
Peterborough Electric Tramways		27,500
Perth (W.A.) Electric Tramway Extensions		30,000
Rochdale Corporation Electric Tramways		22,000
Sheerness Electric Tramways ...		19,000
Swindon Corporation Electric Tramways		35,000
Wolverhampton and Dudley Electric Tramways		8,500
Willesden Urban District Council		4,500
Total completed work		£2,179,200

The Amsterdam-Haarlem Electric Railway—in the construction of which Messrs. White acted as engineers and contractors—is an installation which presented curious difficulties. This line joins the centre of Amsterdam to the centre of Haarlem, and passes thence to Zandvoort, a favourite seaside resort on the neighbouring coast. The distance between Amsterdam and Haarlem is about ten miles, and from the latter place to the coast about five miles by the railway route. From the boundary of Amsterdam the line runs over a private roadway for one and a half miles. To make this portion of the route, 366,000 cube yards of sand were filled in, of which 157,000 cube yards were absorbed by the boggy soil. At the village of Sloterdyk, the line joins the Government high road, on one side of which is a canal, and on the other a ditch. By the terms of the Concession, the whole of this part of the line had to be piled. The amount of the material used here was: 20,500 uncreosoted, and 23,000 creosoted, piles; 3,530 cube yards uncreosoted, and 2,485 cube yards creosoted, timber; 160 tons of iron tierods; 5,000 tons of basalt for projecting slopes; 98,400 cube yards of sand filling; 37,800 square yards of brick paving; 12,250 cube yards of dredging; 1,860 yards of fencing, and 74 gateways to farms and houses. There were

employed, at one time, 2,360 labourers, two steam locomotives, one electric locomotive, thirty-one steam piledrivers, three steam spouters, one steam crane, sixty hand piledrivers, one steam bucket-rigger, and 165 flat boats and scows.

The Kalgoorlie (Western Australia) Power and Lighting Station—for which the same firm acted as engineers and contractors—is a plant containing 2,400h.p. The chief engineering difficulty connected with this plant was the provision of a suitable water supply. At the time of the conception of this scheme, good water was practically unobtainable at Kalgoorlie. The feed water likely to be used showed on analysis over 24 per cent. of mineral matter, as compared with 3.4 per cent of solid matter in ordinary sea water. The evaporating plant consists of ten shell boilers, each 5ft. in diameter and 20ft. long, erected in a detached wooden building. The steam was conveyed from these to a system of cooling drums, consisting of forty corrugated iron drums, each 6ft. 3in. in diameter and 24ft. long, through the centre of each of which passes a flue 3ft. 3in. in diameter. The water supply plant includes four tanks for salt water, each 40ft. in diameter, and 14ft. deep, made of sheet steel plate; and also six fresh water storage tanks, 15ft. in diameter and 8ft. deep. The condensing apparatus consists of three aërial condensers, by Frederick Fouche, of Paris. Each condenser can condense 16,000lb. of steam per hour at a temperature, of the incoming air, of 85° F., and gives, under these conditions, a vacuum of 14in. For cooling these condensers there are twenty-seven fans, each 7ft. in diameter, delivering 2,250,000 cubic feet of air per hour. The fans are operated by nine induction motors of 15h.p. each. The condenser itself is composed of thin corrugated metal plates, forming a series of chambers. This arrangement provides a maximum cooling surface, with a minimum number of joints and connections. The cost of this condensing plant alone was over £16,000.

The contract for the supply and erection of this plant was awarded to Messrs. White and Co. in the beginning of 1900, with the stipulation that the plant was to be in full operation by July 30th, 1902. The work was carried out, and a regular supply of power furnished, on July 23rd of that year.

The reconstruction of the Brixton and Streatham cable line was chiefly remarkable for the celerity with which it was carried out. In fact, this contract created a record for quick work of this description. On March 2nd, 1904, the London County Council officially notified Messrs. White that this contract had been awarded to them, and that, in view of the importance of the thoroughfare, the work must be completed by July 1st, the work comprising the tearing-up of 18,000 feet of double cable line, and the installation of the conduit system. Ground was broken on April 6th; on May 18th cars ran over the double line from Kennington Gate to Water Lane, Brixton Hill, a distance of 1¾ miles. The Board of Trade inspection took place on May 20th—five weeks before time. The average progress on the whole job, by all gangs, was 1,000ft. of single track per day. The whole of the work was completed on June 13th. The first car ran to the terminus on June 15th. The Board of Trade inspection was held on June 18th, and the line was thrown open to traffic on June 19th — twelve days ahead of the stipulated time.

The following is the list of the contracts now being carried out by the same firm:

Contracts in Progress.

Belfast Corporation Tramways (complete construction) ...	£535,000
Belfast, Cavehill and Whitewell Tramways	50,000
Bournemouth (Christchurch extension)	40,000
Dartford Light Railways (complete construction)	83,000
Dundee, Broughty Ferry, and District Tramways (complete construction)	90,000
Falkirk and District Electric Tramways	30,000
London United Tramways ...	165,000
Montevideo (Uruguay) Tramways (complete construction) ...	400,000
Mansfield and District Light Railways	30,000
Wigan (Lancs.) Corporation Electric Tramways	60,000
Rural Tramways, Buenos Aires	250,000
Pará Tramways (Brazil) (complete reconstruction) ...	400,000
Miscellaneous Engineering ...	20,000
Total work in progress	£2,153,000

WATER SOFTENING APPARATUS.

The Exhibit of Lassen and Hjort.

AN important adjunct of tramway power plant in districts where boiler feed water is drawn from the soil and is very hard in consequence is water softening plant in some form or another, this being essential to the satisfactory operation of the boilers. Messrs. Lassen and Hjort are the makers of the Bruun-Lowener patent automatic water softener, and this was on view at their stand. The apparatus performs its functions through the medium of chemical and mechanical processes. Calcium oxide and carbonate of soda are the chief reagents used, and the amount required for a certain amount of water depends on the constituency of the water to be treated. To arrive at this, a careful analysis of the water must be made. In the water softener itself, in which both chemical and mechanical processes act in conjunction, the water is led into one of the chambers of an oscillating receiver. To this is fixed a semi-circular tank containing the technical agents, and at the bottom of the tank is a valve which allows the chemicals to fall into a second chamber This valve is opened at every oscillation of the tank, and it is so arranged that the exact amount of chemical required can be admitted. The limed milk has a strength of 10 per cent. or nearly 100 times that of lime water, a fact which makes it possible to reduce the size of the tanks to contain the lime, in the same proportion. The limed milk is agitated by mechanical means. The chemical mixture passes into a heating chamber, where it is raised to a temperature of 150° F. to precipitate all foreign matter. This heat is derived from steam, but if this is not available the water can be treated cold. The water then passes into a settling tank, and from this is filtered through wood wool, where it flows into the storage tank, from which it is drawn as required. The apparatus is exceedingly simple and compact and every part is easy of access. We understand that over 1,500 of these plants are now at work in various parts of the world.

BRUUN-LOWENEP WATER SOFTENING APPARATUS.

THE HASTE PUMP.

The Haste Pump Co., Ltd.

RECIPROCATING pumps, despite the utmost refinement and apparent perfection of their design, have always possessed undesirable, but seemingly inherent, features. Among these are liability to shock, uneven running, excessive vibration, and other troubles, causing annoyance and sometimes costly delays. It would appear that all these are now done away with by a principle which practically eliminates them all, and which, in practice, certainly gives unlooked-for results. We inspected this pump at the stand of the Haste Pump Co., Ltd., at the Tramway and Railway Exhibition, and were much impressed with its many novel properties. They commend themselves to the users of steam plant especially, by reason of the element of simplicity they at once introduce into an engine house.

Undoubtedly the designs of these pumps are such that the water is dealt with in the most perfect manner conducive to increased displacement and mechanical efficiencies; indeed, the makers claim for this pump the highest mechanical and displacement efficiencies of any pump now on the market. Fig. 1 is a section of the Haste pump, and it will be apparent that in place of changing the area and direction of flow of the liquid pumped, as is the case in most other makes of pumps, the water has an almost straight line of flow and an equal area of flow; hence the inertia of the flowing column of liquid is not destroyed, and does useful work.

Referring to Fig. 1, it will be seen that the pump consists of a reciprocating tube expanded at its centre. In this expansion is placed a valve which works on a guide, the combination being so designed that the water flows between two guiding surfaces—one the expanded tube and the other the conical valve and tapered valve stop. The pump is operated by reciprocating this tube within the two ends, which are, to all intents and purposes, the suction and discharge pipes fitted with glands. On its travel to

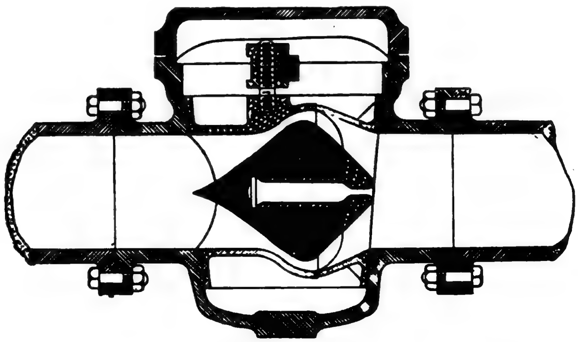


FIG. 2.

the right the valve seats—forms a vacuum—water flows in, and meeting little valve resistance owing to the conical valve, slides past the valve and into the discharge. This may take place at any part of the stroke, in fact, when the speed of the flowing liquid is greater than the speed of the pump—hence the unusual displacement efficiencies obtained with this pump under some conditions.

The valve box, Fig. 2, is of similar design, and is specially arranged so that the valve seating, valve stop, and valve can all be withdrawn for examination and replaced in a few minutes. When the cast iron cover of this box, which is held in place by two bolts, is disconnected, the small nut shown,

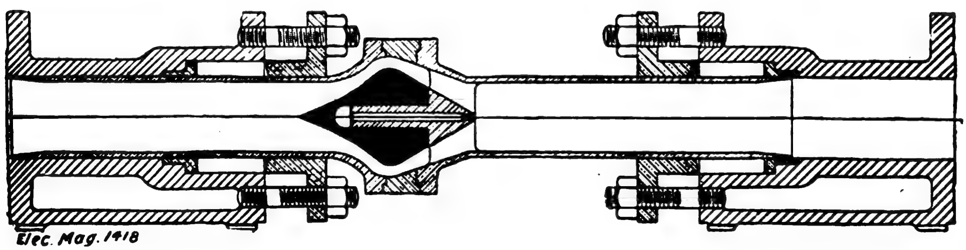
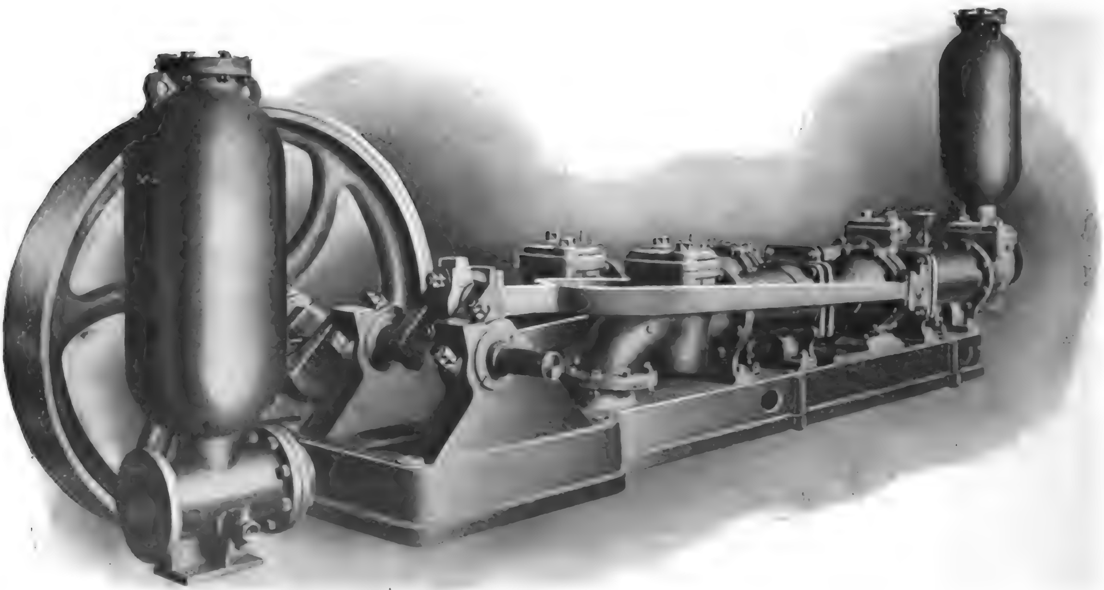


FIG. 1

The Haste Pump Co.,

LIMITED.

Crown Buildings, Crown Court,
Old Broad Street, London, E.C.

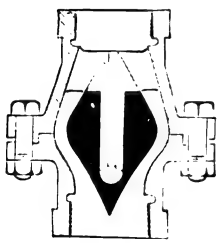


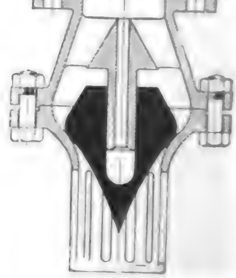
THE MOST EFFICIENT PUMPS

AND

VALVE BOXES

ON THE MARKET.





Telegrams:
"Pumperling, London."

Telephone Nos.:
2369 London Wall.
2967 Central.

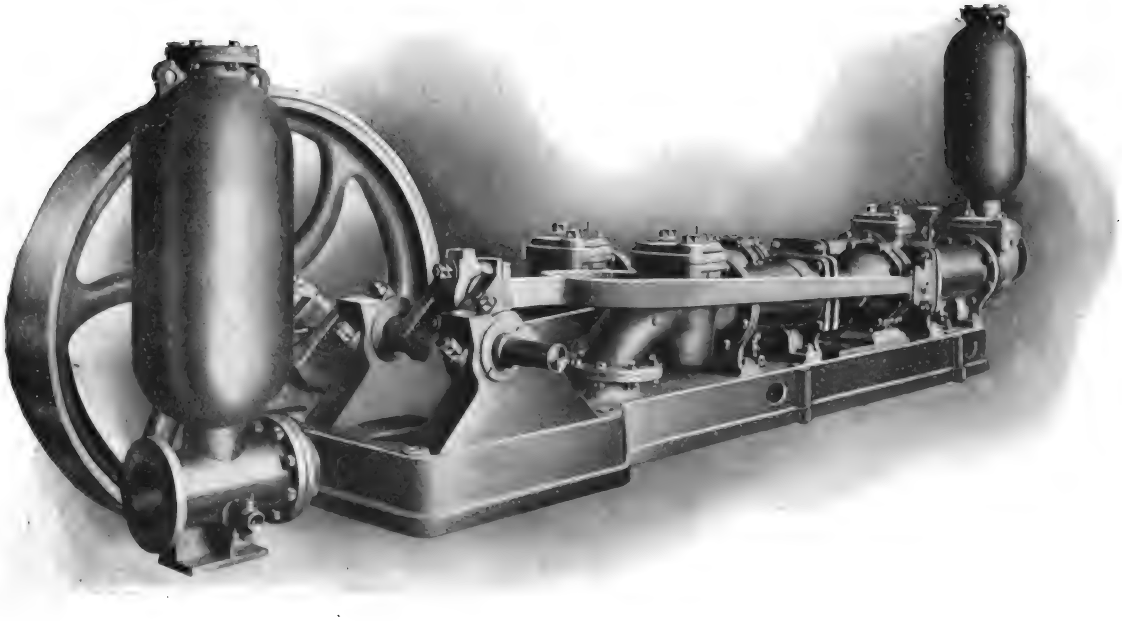


Fig. 3.

on being turned, loosens the shell, which is of gunmetal, from its seat. This valve box is used on the suction and discharge sides of all the company's pumps.

The two-throw pump, Fig. 3, is one constructed on the above principle for pumping oil, and for this purpose it is eminently suitable, and in a modified form for pumping tailings, sewage, &c. The valves of this pump are of the design, Fig. 4, so arranged that the shell which forms the seating, the stop, and valve can be withdrawn for examination by disconnecting two bolts only. A vertical form of steam pump fitted with Haste valve boxes is also manufactured, and a small type of pump suitable for launches and motor cars. Both these were on view at the company's stand.

The company are manufacturers of condensing sets complete, and any of their very interesting pamphlets can now be obtained from their London office, Crown Buildings, Crown Court, Old Broad Street, E.C.

Fig. 4

EXHIBIT OF THERMIT, LTD.

A GREAT many visitors at the Agricultural Hall were attracted to the stand of Thermit, Ltd., the company exploiting Dr. Goldschmidt's patents relating to the creation of high temperatures by means of aluminium. The part of this process which has received the widest attention is the welding of tram rails. Considering the innumerable details connected with the application of so new and practically unknown a force, it is not surprising that only within the last two years has the process been introduced on a large commercial scale.

The marked advantage enjoyed by this system is the absence of any bulky equipment: a crucible, mould, and a rail clamp is all that is required, and these materials, including the necessary quantity of welding compound—so-called "welding portions"—are easily moved on a hand-truck. The mould is made to a model designed specially for each section. Its two parts, one on each side, firmly enclose and exactly fit the rail. It can be made on the track from a mixture of ordinary sand and clay at a cost of only a few pence.

After the reaction, which is started by means of a flaming vesta being applied to a small quantity of ignition powder placed on top of the "Thermit" compound, the iron is separated out and collects at the bottom of the crucible. By pushing up the iron pin, as shown in the illustration, the "Thermit" iron, with the slag following, flows out of the crucible and directly into the mould. The iron flows round the web and foot of the rail, and, melting them, forms one homogeneous mass. The liquid slag is diverted to the top of the rail and brings the latter to welding heat. The whole section is thus heated equally, and the rail ends will not buckle.

With rails embedded in the street, exposing only a small surface to the direct influence of change of temperature, the contraction and expansion are counterbalanced by the friction against the pavement.

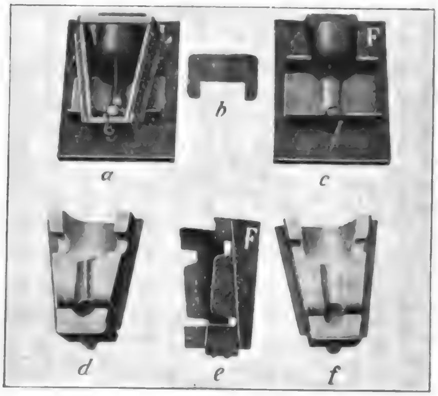
The rigidity of joints made by this process is particularly great. Under hydraulic pressure the break occurs outside the welded zone, as with the iron shoe welded on to the section the joint is really stronger than the rail. The strength of the weld itself is about 80 per cent. of the strength of the original material, but the shoe welded round the foot and web of the rail not only makes up for the remaining 20 per cent., but materially strengthens the rail at the joint. Test rods

THERMIT WELDING OUTFIT IN USE FOR TRAMWAY RAILS

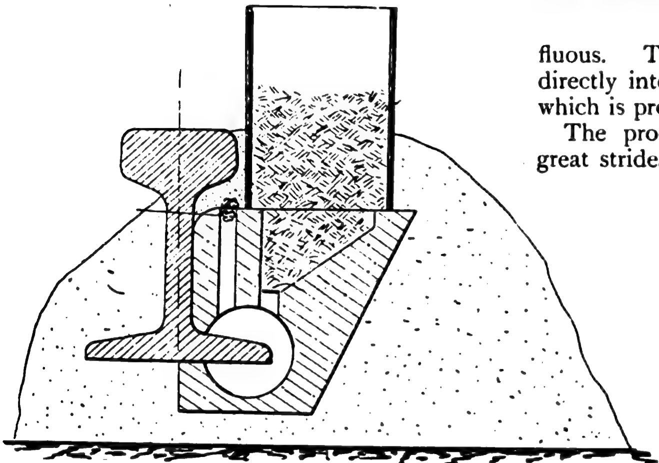
cut out of rails brought to welding heat by the Alumino-Thermic process prove the tensile strength and elasticity have not suffered: a fact which is confirmed by three years' practical experience on the road.

The so-called third rail is also welded by this means. The skin resistance of copper bonds increases with time, and frequent repairs are necessitated thereby. Welding obviates these repairs.

The welding can be done in two ways. The first is identical with the one described before, and is now in operation on twenty miles of Metropolitan track in Paris, where a short track gave satisfaction after a year's trial.



Parts of Thermit Mould.



Section through Rail and Thermit Weld.

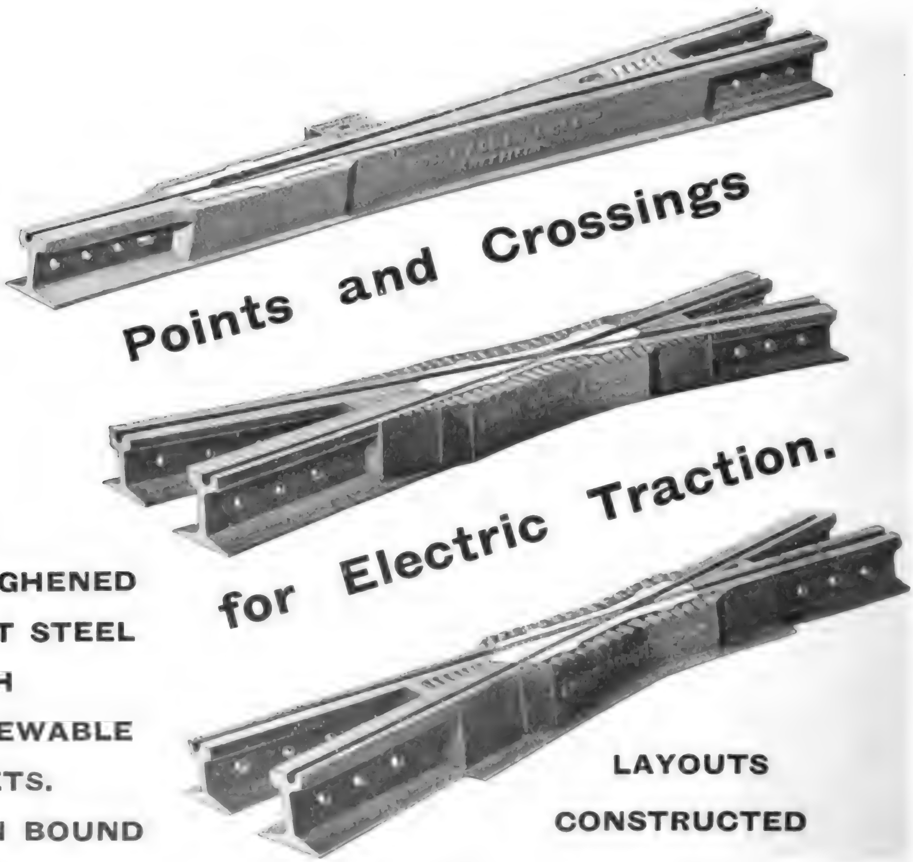
The second consists in welding a small bridge of "Thermit" iron between the feet on one side of the rail. This is used on a large scale: on the suburban road from Berlin to Grosslichterfelds, the Union Electrizitäts Gesellschaft of Berlin has welded thirteen and a half miles of track. The rails on this track are exposed, three lengths are welded to one of 45yds., which is connected to the next by a flexible bond. The other side of the joint, where there is no "Thermit" welded bridge, is mechanically strengthened by an ordinary light fish-plate. In this case a crucible is superfluous. The welding portion is placed directly into the upper part of the mould, which is prolonged by a piece of gas pipe.

The process in this country has made great strides during the last twelve months; a good many towns have adopted it on a more or less large scale, and, if the present favourable indications are borne out by future results, it is not too much to say that this joint will be largely used in the near future, and will, to a certain extent, revolutionise the present methods of permanent way construction, as far as concerns the joints.

Complete Thermit Outfit in Position.

EDGAR ALLEN & CO.,
LIMITED.

Allen's ◇IMPERIAL◇ Manganese Steel



OR
TOUGHENED
CAST STEEL
WITH
RENEWABLE
INSETS.
IRON BOUND
POINTS AND
CROSSINGS.

LAYOUTS
CONSTRUCTED
COMPLETE IN OUR WORKS
Ready for laying on site.

Yorkshire Steel and Engineering Works, SHEFFIELD.

STEEL POINTS AND CROSSINGS.

The Exhibit of Edgar Allen and Co., Ltd.

About two years ago Messrs. Edgar Allen and Co., Ltd., of the Imperial Steel Works and Yorkshire Steel and Engineering Works, Sheffield, purchased the business of the well-known firm of Askham Bros. and Wilson, who had supplied tramway materials from the early days of the old steam tramways. At the Tramways and Railways Exhibition their stand occupied a prominent position in the hall, in fact, one could not very well miss it. They make a speciality of manganese steel points and crossings, which are said to be far superior to cast steel, though engineers still differ on this point. The exhibit comprised a number of interesting examples of point work, among which we noticed some points 15ft. long, which we understand were lent by the Leeds Corporation. These are of toughened cast steel with manganese steel insets. Mattinson's patent movable point, lent by the Manchester Corporation, was also on view. These points are made from the actual rail with a side casting to support the tongue. Two movable points are used, and these are connected together by means of the Mattinson controller. A great deal of interest was taken by engineers in these points. We may mention that the set from Leeds are the longest standard points in Great Britain, and are fitted with McKnight's silencer. On the same stand we noticed a 13ft. 6in. automatic movable point as made for the Hague (Holland) Tramways and fitted with Allen's patent auto-movable arrangement. An attractive feature was the 9ft. 6in. double tongue movable points connected for use on crossovers or, with the addition of springs, for loops. By a special arrangement in the box the points can be fitted with McKnight's silencer.

The attention of tramway managers is specially directed to points and crossings made in Allen's IMPERIAL manganese steel. These are being very extensively used, and among other places a large contract has been placed by the London United Tramways. As our readers are well aware, this is the most extensive system in the west of London, there being thirty-seven miles of track and ultimately some eighty miles will be laid. In 1903 no less than 45½ million passengers were carried, but the extent of the traffic at the present time, which passes over a number of complicated crossings, can readily be gathered. The company, after an extensive experience with the cold cast steel moveable and open points, has now adopted double tongue connected points of Messrs. Allen and Co.'s make in manganese steel. This move on the part of a very progressive company is ample testimony both to the wearing properties of the steel itself and to the design of the points into which it is made up. We understand that Messrs. Allen and Company are now constructing a number of special junctions at their works for this tramway system, and the whole of the points and crossings are in manganese steel, the junctions being fitted together ready for laying on site. At this juncture we may mention that there is unlimited space at the works of the company in which to construct any junction in the exact form it will assume when laid in the roadway.

Figs. 1 and 2 depict a movable point and an extended leg crossing which Messrs. Allen are supplying in cast steel with or without manganese steel insets.

Our attention was specially drawn to the new patent iron bound points, which the company state are a very great advance upon the American type. With these points the standard rails are cast into an iron body and then fitted with manganese steel insets and tongues. They can be made to any standard rails and are also adapted to be fitted with any type of anchor chair required. There is also a difficulty with the fishplates as is often experienced with castings. These points are also made for three ways, and in this case are fitted with a ball bearing action.

A variety of tramcar wheels fitted with rolled steel tyres were on view, and also a number of tyres removed from the wheel centres were shown as specimens of the wear of the tyre after extensive use. We also noticed several cast steel tramcar wheel centres.

Amongst the other exhibits were specimens of special compound work, various tramway anchors, notably Moffet's anchor chair, the Elford patent rail arc, the Wilson channel

joint as used at Royton and Pontypridd, and numerous types of drain boxes, the chief of which was Radford's patent trapped box.

As might be expected, there were several cases containing specimens of the company's steels, notably their air hardened high speed drill; several large rail saws were also shown, and the stand was further embellished with photographs and drawings of special work constructed at Sheffield ready for laying.

A speciality is made of a method of silencing the noise of points at crossings and turnouts. This is a step worthy of all commendation and one which should receive the support of tramway authorities. In most cases the objections in certain localities, residential districts for instance, raised against electric trams is directly traceable to the noise and clatter of the point tongue. It is to the designer and manufacturer that the tramway manager must look for a solution of a difficulty which constitutes in practice a nuisance to residents and a drawback to the extension of lines into areas promising a good revenue. We need not enlarge on the annoyance which can be occasioned by badly designed points; suffice it to say that practical means have been devised for avoiding any undue racket in this direction. At Messrs. Allen and Company's stand automatic points were exhibited with three distinct types of silencer, the McKnight, the Radford, and the Travers. All of these are equally effective, and each will be found to have its own special use. In the public interest these improvements should be fitted to replace excessively noisy points.

FIG. 1. ALLEN'S CAST STEEL MOVABLE POINT, WITH MANGANESE STEEL INSETS.

The entire exhibit was typically British, and gave an admirable idea of the advances made in this particular province. After all, improvements in electrical equipment, rolling stock, and car bodies are of little value unless there is a respectable track laid for it to run on. In the crowded thoroughfares of cities special point work and crossings will always be needed, and it is to the steel maker the tramway manager must turn to solve the many difficulties which face him in this direction.

FIG. 2. ALLEN'S CAST STEEL EXTENDED LEG CROSSING, WITH MANGANESE STEEL INSETS.

SPECIALITIES IN INSTRUMENTS.

Nalder Bros. & Thompson, Ltd.

MESSRS. Nalder Bros. & Thompson, Ltd., of 34, Queen Street, Cheapside, and of Kingsland Green, Dalston, had on view at their stand, No. 34, a very fine collection of electrical measuring instruments of all types; and also some fine examples of switch work. Amongst the instruments there were many varieties of the moving coil type, the round types being made in three sizes, that is 5in., 6in., and 8in. diameter dials. The edgewise type was also shown in many sizes, of which a somewhat new feature is a small instrument having a 5in. scale (Fig. 1). These little instruments, which are very neat in appearance, are made so that they can be screwed on to the front of the board or recessed into it with their faces practically flush.

With regard to the sector shaped instrument, one specially notable feature was a very large station voltmeter of the illuminated dial type, having a scale over 20in. long. This instrument would be particularly suitable for fixing on an adjustable bracket in a generating station, so that the voltage could be read from any part of the building.

Among the switchboard instruments, we noted the N. C. S. patent wattmeter, which operates on an entirely new principle, patented by Dr. Drysdale. The pressure coils are so wound as to have no self induction, consequently the usual correction due to the self induction of the pressure circuit is not necessary. This is most important, as it means that the errors on low power factors, which are usually quite large in this form of wattmeter, are extremely small; in fact, with a power factor as low as .1 an accuracy of 1 per cent. can be obtained.

The construction of the instrument (Figs. 2 and 3) is as follows:—

Current coils are wound round soft iron cores, so arranged that there is an exceedingly small air gap, the consequence being that an intense field is provided. The high moving forces in the instrument, together with the small liability of disturbances from external fields, give marked advantages with the instrument.

In the air gap are placed two pressure coils, rectangular in shape, and flat, and only $\frac{1}{50}$th of an inch thick. The direction of current round the current coils is so arranged that one of them tends to move up and the other to move down. In the latest design, however, it has been found more convenient to fix one coil and allow only the other to move. The vertical motion is transmitted by means of a fine wire acting over a pulley, attached to the main spindle, to which the pointer is attached, this vertical motion thereby being translated into an angular one. The scale of the instrument is almost even, and the instrument represents about the best form of wattmeter on the market.

There was also an exhibit of instruments for making the tests prescribed by the new

FIGS. 2 AND 3. N.C.S. SWITCHBOARD WATTMETER.

Home Office regulations. These consist of ground detectors of the electrostatic type, suitable for direct or alternating currents, and also instruments provided with switches for testing the insulation of resistance to the mains in a two wire system.

There was a remarkably good show of portable instruments for both direct and alternating currents. Generally speaking, for direct currents the moving coil instrument is employed, and for alternating current the soft iron system. In the case of the soft iron instruments these were all fitted with an improved form of air damping to make them dead beat.

A very convenient line of portable instruments was shown, with cases of leather finish, the instruments being extremely light and portable, and we also noticed some screened patterns of moving coil instruments. These would be suitable for testing in strong magnetic fields, and for machine motors in generating stations. (Fig 4).

The firm's exhibit of recording instruments covered pretty completely the ground required by this class of apparatus. The moving coil type of recorder generally was shown in a black enamelled iron case with nickelled fronts. In the first type the chart or record sheet is of sufficient length to give a twenty-four hour record. The second class were those of the continuous record pattern, giving a month's supply of paper, the paper speed of this instrument being 1in. per hour. Of course this speed can be changed to give 1in., 2in., 3in. or 6in. per hour as desired.

For alternating current work this firm were showing soft iron recording instruments fitted with oil damping attachment, both in

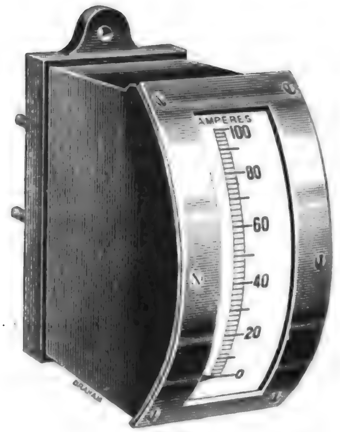


FIG. 1. N.C.S. EDGEWISE AMMETER

polished wood and enamelled iron cases. Special care has been taken in the design and construction of these instruments to eliminate errors due to wave form and periodicity.

A line of h.t. instruments was illustrated in several types, there being alternating current instruments in iron cases, in all instances equipped with pressure reducing transformer. A large sector instrument was shown having a scale 3,000 to 8,000 volts, suitable for three phase work on 6,000 volt circuit. This part of the exhibit was shown working, and on the high tension side of the transformer was an Ayrton Mather electrostatic voltmeter, which read directly up to 10,000, giving a perfectly even scale. Current transformers were also shown, which reduced the current to a low pressure, thereby reducing the danger of current due to high pressure coils on the instruments.

FIG. 4. SMALL PORTABLE TESTING BOX

TOOLS AND GAUGES.

The Exhibit of Thomas Chatwin.

EVERY tramway department must have adequately equipped repair shops, and special tools are indispensable for this equipment. In these days of extreme accuracy, properly designed gauges are also essential in the workshop. At the stand of Thomas Chatwin every conceivable tool required in the car shed was on view. We specially noticed Chatwin's straight-fluted hand reamer, which entirely obviates the fault of rivelling and chattering, or producing an uneven hole, common to many forms of hand reamer. The makers have such confidence in this that they are prepared to submit it to any reasonable test which customers may require. The results of an extensive experience with this tool convinced the makers that when once used it will always be in demand. A number of milling cutters for use on high speed and carbon steel were also on view. For high speed drills, which are a speciality of Thomas Chatwin, a new high speed steel has been adopted. Very gratifying results have been obtained from this steel, and all standard sizes of drills are stocked in it. The steel was only selected after very careful experiments, as the makers had learnt from a rather bitter experience that many so-called high speed drills are no better than the older pattern of drill made from carbon steel. We may mention that the firm still make twist drills from carbon steel, and recommend their use for work where the speed and feed are ordinary. The gauges shown were very interesting. Standard cylindrical reference gauges are made in hardened steel, and in all sizes up to 6in. in diameter. They are accurately ground to the 1/20,000th part of an inch, and are produced with the utmost care on up-to-date machinery. The accuracy, we may say, is in every case guaranteed by the makers. Limit gauges are now recognised as an indispensable adjunct to the tools of the up-to-date workshop. Messrs. Thomas Chatwin have had an exceptional experience in this direction, which we understand is placed entirely at the service of their customers. A wide range of sizes is manufactured to any desired limit of accuracy. Screw-thread gauges are also very extensively used, and several forms of these were exhibited. Gauges of this type are made for Whitworth Standard, International Standard (metrical), and special threads.

A very useful tool was exhibited in the shape of a screwing machine fitted with an automatic release to the dies. We illustrate this in Fig. 1, from which the compactness and elegance of design of the machine will be at once apparent. The machine is capable of screwing a full thread on bolts from ½in. to 2in. in diameter, at once going over. It can be supplied with taps and holders for nut tapping of the same sizes. In a tramway workshop it will be found indispensable for the screwing of tiebars. This machine has a three-speed cone pulley and overhead driving gear. The vice is open-jawed and self-centring. The dies are in four pieces and screw a full thread at once going up. The automatic releasing motion can be set to open the dies any distance up the bolt, according to requirements, and as the dies are set up to size again instantaneously and accurately after pulling the lever forward, they automatically close to the exact size, therefore screwing can be effected in the most rapid and economical manner. There is a reservoir for oil in the bed of the machine, from which a pump supplies a continuous stream of oil to the dies and taps, which returns, after filtration, to be used again. A tap in front of the machine serves to drain off the oil at any time.

The gear wheels, which are machine-cut from the solid, are protected by a cast-iron guard. This is a thoroughly up-to-date tool, the workmanship and materials throughout are of the very best quality, and the machine can be confidently recommended to tramway managers. The machine can, of course, be arranged to drive either from an individual electro motor or from an overhead shaft.

Among other specialities in the way of tools manufactured by Thomas Chatwin are stocks and dies, taps, wrenches, screw tools, die nuts, surface plates, lathe carriers, and swivel tool holders. Among special tools we may mention Jones' patent mains pipe cutter, for cutting mains up to 42in. in diameter; ratchet braces, tube cutters, spanners, and wrenches are also manufactured in stock.

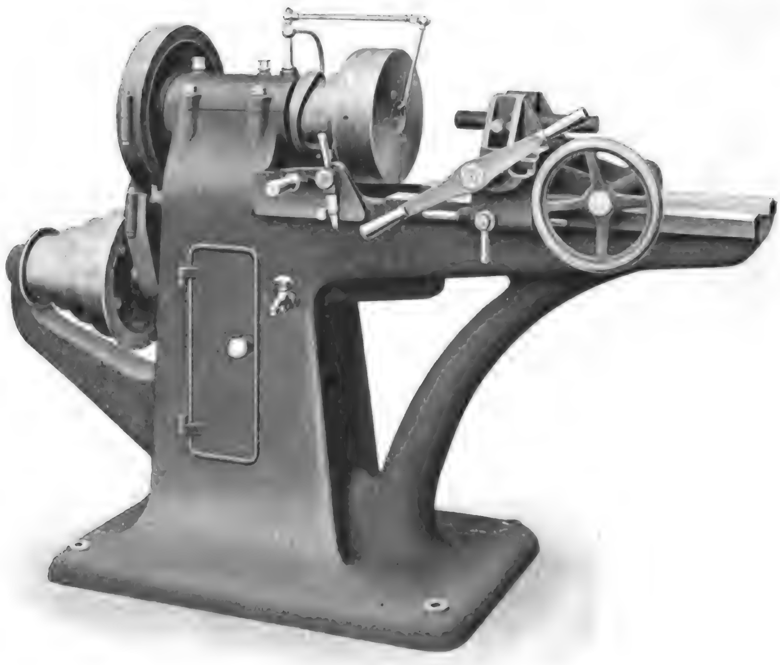
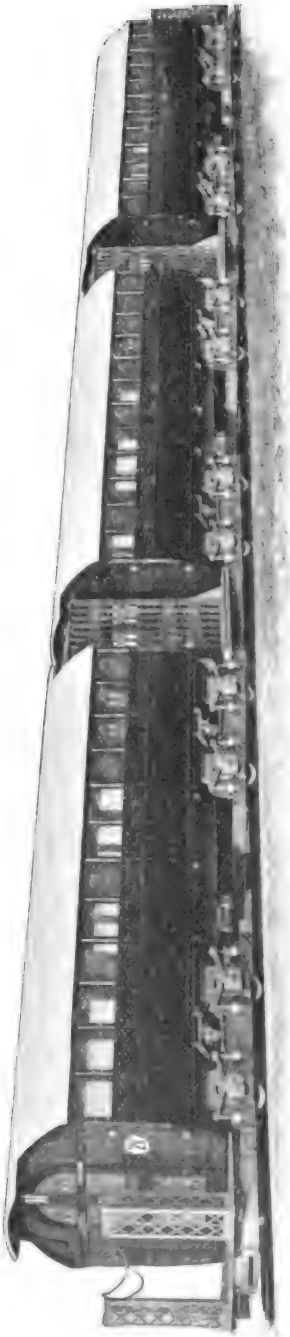


FIG 1. CHATWIN'S SCREW-CUTTING MACHINE, WITH AUTOMATIC DIE RELEASE.

The importance of providing a tramways system with good workshops, having up-to-date equipment, should not be overlooked by tramway managers. Neglect in this quarter may result in serious delays and bad break-downs. With proper tools and a well-trained staff accidents can frequently be anticipated and repairs effected in time. A parsimonious policy in workshop matters is bound to reflect on the undertaking as a whole. In this respect, an economically minded manager may regard repair shops as a necessary evil, and, in consequence, fit them up with, comparatively speaking, primitive tools. The matter, however, is one of engineering importance, and for this reason demands that the accuracy invariably associated with engineering methods be also sought in this direction. Tramway managers may rest too much on the belief that their overhead equipment and rolling stock is now standardised, and very little else requires to be done in keeping the system in good order. It might be remembered that attention to details contributes more than anything else to the success of any undertaking, and it is only by the adoption of modern methods in every department of a tramway system that these results can be obtained.

Although Americans cannot now teach us much regarding the constructional details of a tramway system, either in the power house, on the line, or with the rolling stock, they are particularly solicitous for the welfare of these things when laid down, and are accordingly generous in repair shop equipments. Moreover, they conduct the shop on systematic lines and insist on the best tools and the best method of operating them. It is useless to argue that the rolling stock can take care of itself, and such small repairs as are needed can be effected by ordinary tools with ordinary methods. The exhibit of Messrs. Chatwin gave the lie to this, and emphatically so. We hope tramway managers will realise the value of good tools, and remember that they can only be obtained from reliable and experienced makers.

HURST, NELSON & CO.'S, LTD., STAND.



City and South London Railway Train (Hurst, Nelson and Co., Ltd.).

Messrs. Hurst, Nelson and Co., Ltd., had a large exhibit of railway and tramway plant and accessories, the whole of which had been made at their chief works at Motherwell. They were showing a four-wheeled double-deck electric car built for the Kilmarnock Corporation to the designs of Messrs. Kennedy and Jenkin. The car is mounted on the "Hurst Nelson" standard solid forged frame truck, and is also fitted with the firm's patent sand valves and folding steps. A solid forged frame four-wheeled truck arranged for a 3ft. 6in. gauge was shown, also their standard forged frame maximum traction truck. These trucks are fitted with their own design of steel tyred wheels with forged steel axles.

They showed also a standard 12-ton steel frame waggon fitted with side, bottom, and end doors, and embodying all the latest requirements. Their lighter plant included an either-side steel tipping waggon equipped with patent pressed steel tipping standards, and this waggon was standing on one of the firm's self-contained turntables.

The firm have a special plant at Motherwell for the manufacture of hydraulic pressed wrought-iron wheel centres; and centres were shown in the different stages of manufacture, attracting considerable attention.

A cast boss, wrought-iron spoked wheel was also shown.

The remainder of the exhibit included a self-contained buffer with pressed steel cylinder for the conversion of solid buffer into spring buffer waggons; a roller bearing axle-box, for railway stock, which has already run several thousand miles; types Nos. 1 and 2 of the Ratqua rail anchors, of which Messrs. Hurst, Nelson and Co., Ltd., are the sole manufacturers, and of which they are at present executing large orders; various railway and tramway pressed steel details, forgings, and stampings, together with a number of photographs of vehicles which they have already turned out.

Altogether the exhibit gave an excellent idea of the scope of the company's manufactures, although it is to be regretted that they had not sufficient space to exhibit either a railway carriage or a steam motor coach, as they are presently building twelve of the latter for the Great Western Railway Company.

GREEN'S ECONOMISER EXHIBIT.

The primary object of trade exhibitions is to bring together the latest inventions and devices in any way connected with the particular trade or industry represented. It may be assumed, therefore, that the most up-to-date development in tramway construction and propulsion were shown at the Tramways and Light Railways Exhibition. There was much that was new and some that was old, probably the oldest—an invention that dates back over half a century, but still retains the premier position in its particular line to-day—notwithstanding the mechanical revolution during that period. This was the exhibit of Messrs. E. Green and Son, Ltd., of Manchester and Wakefield. This firm had on view a good working model of the well-known Green's Economiser applied to a Lancashire boiler, showing the setting in main flue, by-pass flue, arrangement of dampers, &c. Electrical energy for power purposes being mainly generated by steam plant, fuel economisers are a necessity wherever this is the force employed. Thus at an exhibition of this nature steam exhibits commingle with the electrical.

Green's economiser is adopted by steam users the world over, and its merits as a fuel saver have been so frequently described and so universally admitted that it is only necessary to remark that the model was a very complete representation of how to reduce the coal consumption by utilising the waste heat in gases escaping from steam boilers. The illustration shows Messrs. Green's stand—economiser model at the back and the boiler feed pumps in the foreground. The other exhibits on this stand were two boiler feed pumps—one a double ram with fly wheel and the other of the direct acting type. For this latter, which has just been placed on the market, special advantages are claimed—notably few working parts and simplicity in construction. It is of neat design, compact, and occupies little space. The design is quite different from other pumps of this class. The special feature in construction is that there are no tappets or auxiliary valves, no rods to become bent, broken, or to get out of alignment, no rollers or clamps to be adjusted—all of which are subjected to great wear and leakage, thereby soon destroying the action of the pump.

In the design of the Wakefield pump there is only one "equilibrium steam-tight valve," and for this reason it is claimed to be the most economical, reliable, and simplest pump on the market. The novelty in this valve is such that it is positive in action at all speeds and at all steam pressures to which a pump is subjected. Moreover, there is no wear on the valve. The only other working part in the steam-end of the pump is the piston, and the surface of this in contact with the walls of the cylinder is so large that neither the piston nor the cylinder has any practical wear.

In the water-end of the pump the working parts are the water-valves and plunger. This plunger is also of deep type and fitted with improved composition packing, having natural springs which keep the packing well up to the walls of the barrel without excessive pressure. The above advantages enable the Wakefield pump to keep up its duty longer than any other pump without renewal of parts. The pump will run from 25 to 100ft. piston speed per minute without any shocks or injurious effect. This will be appreciated by engineers at electric power stations where the load is variable. In the day time it can be worked at a low speed, and at night, when increased boiler power is required, the speed can be increased as desired. There is absolutely no wear in the Wakefield steam valve even after years of working.

View of Green's Economiser Exhibit.

THE EXHIBIT OF FASTNUT, LTD.

Engineers are familiar with the innumerable devices for locking nuts securely in position, and generally express their opinion of them in accordance with the moods they happen to be in. The Fastnut method exhibited by Messrs. Fastnut, Ltd., has, however, features which commend it to the notice more particularly of tramway engineers. Quite frequently accidents can be traced to nuts working loose on some vital part of a car which is subjected to unusual vibration. In fact, the use of split pins has become quite common for want of a better method of keeping a nut in its place.

The Fastnut washer is guaranteed by its makers to be entirely unaffected by vibration. Fig. 1 shows various views of the washer and gives an excellent idea of its construction. It is made of steel out of a single piece of metal, and requires no fitting or attention of any sort. It can be dropped into its place in the ordinary way, and the act of screwing up the nut causes the teeth to grip the bolt and the flange to hold the nut. The washer will securely hold all nuts, studs, and screws in such a way that they cannot work loose under vibration, nor will the process of wear in any way loosen the grip. By the use of this washer an ordinary washer is not needed, and the necessity for check nuts and cotter pins is quite dispensed with.

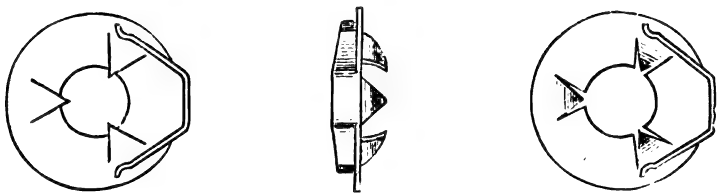


Fig. 1 Different Views of the Fastnut Washer.

The device is very extensively used in engineering and tramway circles, and has been found to give great satisfaction under every conceivable test in actual practice; in fact, the claims of the makers for its efficiency have been substantiated in every practical instance. The Accident Insurance Co., Ltd., are prepared to make a 5 per cent. reduction in their premiums for the insurance of third-party (general public) risks to all motor car owners using these washers throughout their cars. A better testimonial than this would be hard to find. We reproduce two typical letters expressing the appreciation of Fastnut washers by different users.

[COPY.]

Unsolicited Testimonial.

Motor Agent. Douglas S. Cox,
Garage. Thomas Place, Norwood Road,
West Norwood, S.E.

Messrs. Fastnut, Limited. July 5th, 1905.

Dear Sirs,—I have tried the Fastnut washer you sent me on various places where I have usually had trouble in keeping nuts tight, and your washers appear to be a perfect success. After two months' trial not one of the nuts so fixed have worked in the slightest degree loose. You may expect further orders from me shortly.

Yours faithfully,

(Signed) Douglas S. Cox.

[COPY.]

Owners of the Kingsland Mechanical Surface Contact Patents.

The Traction Corporation, Ltd.,
16, Great George Street,
Westminster.
July 12th, 1905.

Messrs. the Fastnut, Ltd.,
60, Aldermanbury, London, E.C.

Dear Sirs,—We have much pleasure in recording that during the last exhibition we tried your Fastnut washer on some equipment we had running there, and we found all your claims fully justified.

Faithfully yours

(Signed) Robert Brown.

Principal Exhibits at the Tramways and Railways Exhibition.

(*Specially Classified for Reference.*)

THE POWER STATION.

Boilers, Coal Conveyors, Stokers, &c.

Generating plant is, of course, indispensable to the operation of electric tramways; consequently interest attaches to exhibits of apparatus used in the power house. The Stirling Boiler Co., Ltd., showed working models of their four and five drum type boilers and photographs of typical installations. Babcock and Wilcox, Ltd., were showing their silent gravity bucket conveyor for coal, coke, ashes, &c., and also models of their water tube boiler, mechanical chain-grate stoker, and water softening and purifying plant (Guttmann's patent). The exhibit of Graham, Morton and Co., Ltd., included five different kinds of conveyor for handling coal and other heavy material. The apparatus was shown in motion with coal passing continuously through the whole plant. Superheated steam is now regarded as an essential in power house economics, so that McPhail and Gibson's superheater exhibit was of considerable interest. It included an element of their independently fired superheater and several specimens of cold drawn steel tubes. Meldrum Brothers, Ltd., were showing their now famous stoker and several examples of their patent furnaces. A model of Meldrum's patent top fed regenerator refuse destructor was a feature of the stand. The Under-feed Stoker Co., Ltd., who make a speciality of supplying coal to the fire from below the grate bars, were exhibiting examples of their specialities, and the Triumph Stoker, Ltd., were also showing their machine, which is of the sprinkler type. Another stoker of the sprinkler type is that of J. Procter, Ltd., which can be applied to either Lancashire or water tube boilers.

Pumps, Piping, Pyrometers, &c.

The Western Electric Company was showing a number of their electrically driven pumps, and the Edwards Air Pump Syndicate, Ltd., exhibited a set of three-throw motor-driven pumps, which were shown in operation. These have been fitted into more than 220 British and American stations. The Fery patent direct reading radiation pyrometer for taking temperatures from 500° C. up to any higher limit was shown by the Cambridge Scientific Instrument Company. Aiton and Company made a good showing of pipe work and steel piping, and were also showing a grease separating pump and exhaust head and silencer. Pipe coverings were also in evidence, the stand of the British Johns-Manville Co., Ltd., being specially attractive. A. Haacke and Company were showing their fossil meal for covering boiler and steel pipes, and a removable flange cover used largely in connection with their boiler covering.

Gas Plant.

Among the exhibitors of gas plant we noticed the General Railway Engineering Co., Ltd., and Crossley Brothers, Ltd. The latter had seven engines on view, two of which were coupled to small dynamos for lighting the stand. The gas producer industry had a single representative in Mason's Gas Power Co., Ltd., who were showing a 120h.p. Duff-Whitfield gas producer and a 40h.p. suction plant.

Dynamo Electric Machinery.

Large traction generators were conspicuous by their absence from the exhibition, and only two firms were showing auxiliary dynamo electric machines. Bruce Peebles & Co., Ltd., on their spacious stand found room for a 400kw. motor converter for converting from 6,600 volts three-phase to 550 volts continuous current. This particular machine is one of ten to the order of the Great Western Railway for its Park Royal Station. The Lancashire Dynamo and Motor Company were showing their Lancashire automatic reversible booster specially designed for traction work. In conjunction with this was a booster switchboard made by Bertram Thomas and fitted with Elliott instruments and Chamberlain and Hookham meters.

Switch Gear.

There was a fair showing of switches and switchboards for traction generators and feeders. J. G. Statter and Company were in the main entrance, and had a variety of apparatus on view, the chief attraction being an automatic battery regulator. Almost opposite their stand was that of Everett, Edgcumbe and Co., Ltd., which was well stocked with switchboard instruments, testing sets, photometers, and wattmeters. Kelvin and James White, Ltd., also had a number of instruments on view, and among these we noticed several of the portable type, including an insulation testing set and a rail bond tester. Nalder Brothers and Thompson, Ltd., are specially referred to elsewhere. Elliott Brothers had fitted up an attractive stand, which was audibly indicated by the buzz of its speed indicators. The firm's chief specialities in switchboard and portable apparatus were on view. Foxcroft and Duncan exhibited an accumulator switch-

board and main and branch switches of the knife type; and R. W. Blackwell and Co., Ltd., had a fine range of I.T.E. circuit breakers set up on their stand. Dorman and Smith, who specialise in switch gears, were showing their grip contact circuit breakers and time limit relays, and the back of the stand was completely filled by a large main traction switchboard. Cowans, Ltd., drew a goodly company to their stand by practical demonstrations with their circuit breakers. Andrews reverse current circuit breakers proved quite an attraction, as did also the A.C. discriminating release gear, as supplied to Poplar, Bristol, &c. This release is guaranteed to isolate a faulty generator with a failing field, and also with a failing engine.

Cables and Distribution.

The Western Electric Company had a quantity of samples of their paper insulated, armoured and unarmoured cables set up on their stand. A feature of these was the 11,000 volt cable for the Baker Street and Waterloo Railway. Callender's Cable and Construction Co., Ltd., were fenced in with cable railings, and were also showing several types of their feeder pillars in which the fittings are mounted on double porcelain insulators in iron supports, this arrangement dispensing with the usual marble and slate bases. W. T. Henley's Telegraph Works, Ltd., exhibited examples of high and low tension cables insulated with vulcanised india-rubber, paper, jute, and gutta-percha insulation. Various improvements in fuse boxes and feeder pillars were also shown. I. Frankenberg and Sons, Ltd., had an attractive exhibit of wires and cables for all classes of work and every known system. Various stages of rubber manufacture were also shown by samples taken from the crude state up to the finished article. Tapes, rubber shoes, macintosh coats, and waterproofs were also among the specialities on view. The St. Helens Cable Co. had one of the best cable exhibits in the Hall, and attracted considerable attention by their Dialite specialities.

TRACK WORK.

Rails, Points, &c.

The Lorain Steel Company exhibited three pieces of special construction work showing their standard town open point and crossing. These points were cast steel and the crossings were made of the actual rolled rail. At each intersection there was a specially hardened and toughened steel plate prepared by a secret process which imparts a life to points and crossings of from two to three times that of ordinary construction. Bayliss, Jones and Bayliss, Ltd., were showing a number of pie bars and permanent way fastenings as well as standard sizes of cast iron chilled paving blocks. L. P. Winby and Company exhibited the Winby patent anchor rail joint and anchor chair. The latter are made from rolled steel joists of various sections, and by means of a steel key are firmly wedged up to the rail. J. Yates and Co., Ltd., had a great variety of track tools on view, exhibiting everything from an adze to a rammer. The Forest City Electric Company are bonding specialists, so that considerable interest attached to their exhibit. They were showing their protected rail bond of flat copper wire, on which terminals of pure wire are cast. These are fixed into the rail web by pressure. Double screw and hydraulic compressors for installing protected rail bonds were also shown. Rail grinders and drilling machines were to be seen at the stands of R. W. Blackwell and Company, C. W. Burton, Griffiths and Company, John Yates and Co., Ltd. The Continuous Rail Joint Company of Great Britain exhibited their patent rail joint, which is a combination of fish plate and sole plate rolled into one piece from the best quality steel. Over 20,000 miles of tramway and main line railways are equipped with these joints.

THE ROLLING STOCK.

Wheels, Trucks, &c.

The Empire Roller Bearings Co., Ltd., exhibited amongst other things examples of their tramway axle-box fitted with roller bearings, steel sleeve, and swivel liner. The exhibit of Hurst, Nelson and Co., Ltd., is referred to elsewhere. Wheel presses were exhibited by Miller and Co., Ltd., and C. W. Burton, Griffiths and Company, and the stand of J. Baker and Co., Ltd., was an excellent example of what can be done with steel tyred wheels. A number of rolled steel wheels and wheel-centres were also on view. The truck exhibits were not numerous, but very good. To Messrs. Mountain and Gibson's specialties we refer elsewhere. The Brush Electrical Engineering Co., Ltd., on an extensive stand were showing five of their special trucks: the equal wheel bogie truck, the standard maximum traction truck, the Eureka maximum traction truck, the standard four-wheel truck, and the radial truck. One or two of these were fitted with motors and shown in operation.

Cars, Trolley Standards, and Accessories.

The Brush Electrical Engineering Co., Ltd., exhibited two cars made at their Falcon Works. One of these was taken from a number now building for Belfast, this being fitted with special ventilating devices, spiral staircases, and folding steps. The other car had been built for the Rochdale Corporation and was designed to enable an equal wheel bogie truck to be run without unduly raising the car floor above rail level. Trolley wheels and standards were very well represented. The Railway and

General Engineering Co., Ltd., had a patent trolley head on view which overcomes the liability of the head to become entangled in the overhead equipment should it leave the trolley wires. Fleming, Birkby, Goodall and Co., Ltd., showed a variety of trolley heads. and other exhibitors of these specialities were Brecknell, Munro and Rogers, R. W. Blackwell, and Thomas Noakes. Specialities in the shape of trolley bases, bushes, poles, and catchers were to be seen at the stalls of S. Dixon and Son, Ltd., the Wallace Supply Company, Cowans, Ltd., and Player and Mitchell.

OVERHEAD EQUIPMENT.

Trolley Wire and Line Material.

The St. Helens Cable Company are large makers of trolley wire, and their exhibit also included cable and insulation specialities. There was naturally a big show by makers of every conceivable class of insulation for the trolley line. The Electric Tramway Equipment Company displayed various specialities in the way of hangers, pull-offs, ears, frogs, and switches. The British Johns-Manville Co., Ltd., were showing their Vulcabeston insulating material made up for trolley line purposes. Robert Blackwell and Co., Ltd., included in their extensive and comprehensive exhibit a full line of Ætna insulators. These are too well known to need description.

MISCELLANEOUS.

A considerable number of the exhibitors displayed a quantity of apparatus and materials which afford important accessories to the many adjuncts of a tramway system. Among these we may mention the A B C Coupler Co., Ltd., Ames-Croster Sanitary Engineering Co., Ltd., Aron Electricity Meter, Ltd., I. Bentley and Co., Ltd., Berry, Skinner and Company, Brooks, Ltd., Circulators, Ltd., Fire Resisting Corporation, Ltd., Glacier Anti-Friction Metal Co., Ltd., Holden and Brooke, Ltd., Knowles and Wolaston, Le Carbone, G. Lister, Mellowes and Co., Ltd., Millar's Karri and Jarrah, Ltd., Blair and Mitchell, Pollack and McNab, Ltd., Simplex Steel Conduit Co., Ltd, J. E. Spagnoletti and Co., Ltd., Standard Varnish Works, Sturtevant Engineering Co., Ltd., Vacuum Oil Co., Ltd., John Yates and Co., Ltd., Philipson's Life-saving Apparatus, Brockie-Pell Arc Lamp, Ltd., and Hudson and Bowring, Ltd.

MOTOR 'BUSES.

The motor 'bus has now come to be regarded not as a rival of, but a useful accessory to, electric tramways; consequently the appearance of several of these comparatively new vehicles at the exhibition occasioned no surprise. The Motor Car Emporium, Ltd., exhibited a double-decked 'bus as supplied to the leading railway and omnibus companies. This is designed to carry thirty-six passengers, exclusive of driver and conductor, and is fitted with a 30h p. engine. On the same stand was a 5 ton petrol lorry, twenty-seater char-à-banc, and a convertible lorry delivery van and waggonette. Another interesting exhibit was that of the Peebles Steam Car Co., Ltd., who were showing a self-propelled steam railway car to carry thirty-three passengers; the motive power equipment consists of a light high duty water tube boiler supplying steam to a compound engine geared to the car-axle.

SPECIAL TRAMWAY SYSTEMS.

Despite the popularity of the overhead trolley wire, surface contact systems are still advocated, and in a number of instances are being put down. The Traction Corporation, Ltd., which exploits the Kingsland Mechanical Surface Contact System, had laid down a short length of track in the hall on which a motor truck was run to illustrate the principle by which energy was supplied to the car. The arrangement of mechanically operated switches and contact studs has much to commend it; in fact, the system appears mechanically superior to magnetically operated devices. The system allows of the passage of cars in either direction, so that a double service can be run on a single line track. The Lorain Steel Company exhibited specimens of their contact boxes as installed at Wolverhampton, and the Dolter Electric Traction Co., Ltd., displayed a model of their system in the Minor Hall. An experimental model car was run up and down the short length of track to demonstrate the operating features of the system.

Raworth's Traction Patents, whose system of regenerative control may be regarded as something special and almost revolutionary, had a large stand on which were displayed examples of their controllers and shunt motors. The back of the stand was filled with a large curve graphically depicting the economies obtained by the system, and the ornamental setting of this curve was sufficiently attractive to draw a large crowd.